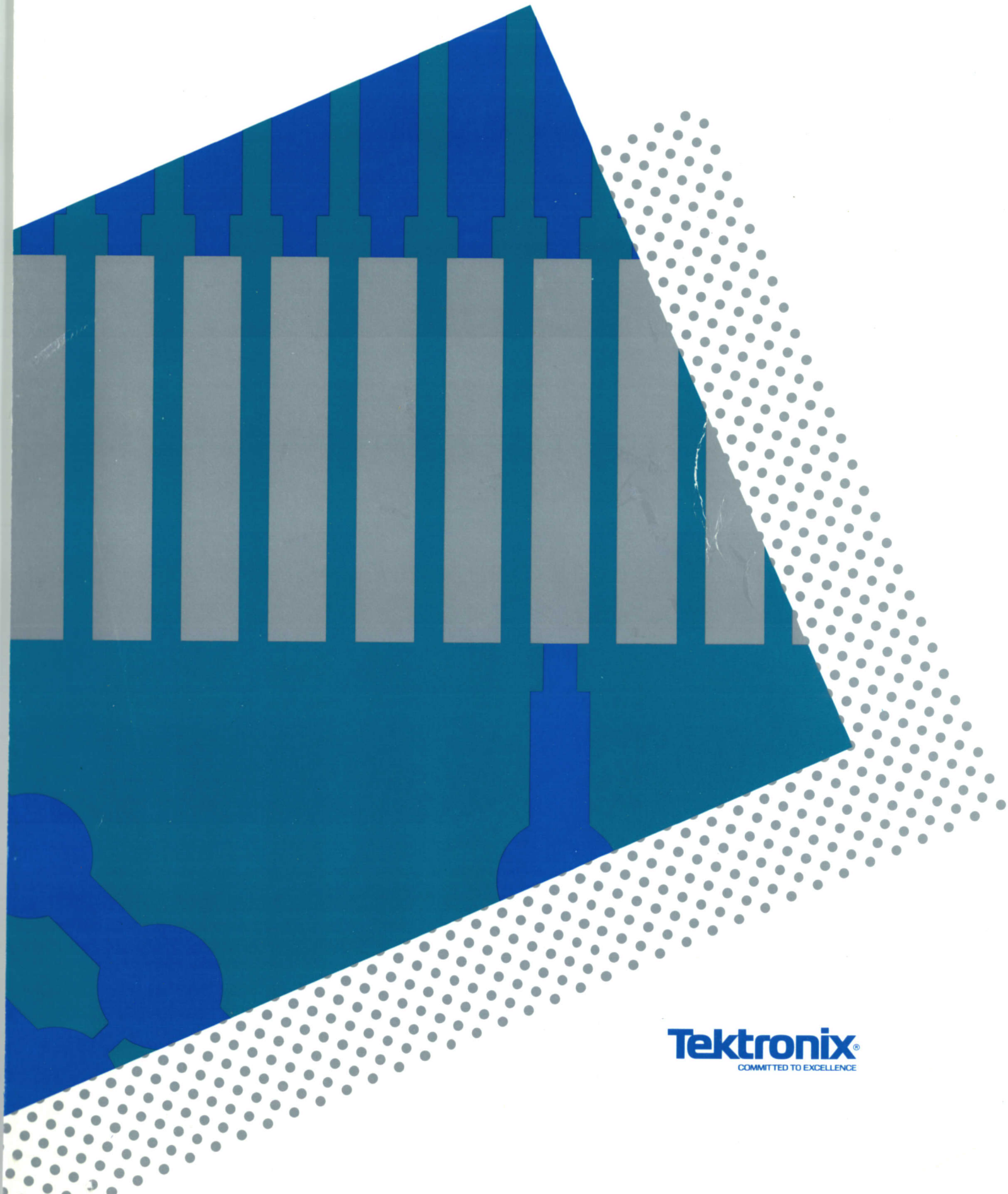
Tek Products 1988



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CONTENTS

IMPORTANT INFORMATION

INDEXES	2
GPIB PRODUCTS REFERENCE	14
SOFTWARE SUMMARY	26
COMPONENT DESIGN & PRODUCTION SERVICES	28
DISPLAY PRODUCTS	36
DISPLAY TECHNOLOGY REFERENCE	42
WORKSTATION FURNITURE	79
CUSTOMER SERVICE INFORMATION	536
TRAINING	219, 542
SALES AND SERVICE OFFICES	546

INFORMATION DISPLAY

PC GRAPHICS	51
COLOR GRAPHICS TERMINALS	53
GRAPHICS WORKSTATIONS	57
ARTIFICIAL INTELLIGENCE SYSTEMS	67
APPLICATIONS SOFTWARE	69
COLOR OUTPUT SYSTEMS/PRINTERS	73
GRAPHICS RASTERIZER/TABLETS	75
GRAPHIC INPUT WORKSTATION	77
SUPPLIES	78

DESIGN AUTOMATION

COMPUTER-AIDED ENGINEERING	84
COMPUTER-AIDED SOFTWARE ENGINEERING	91
LOGIC ANALYZER PRODUCTS	103
SEMICONDUCTOR TEST SYSTEMS	134

COMMUNICATIONS

TELEVISION PRODUCTS	138
COMMUNICATIONS NETWORK ANALYZERS	155
SPECTRUM ANALYZER PRODUCTS	162

INSTRUMENTS/SYSTEMS

LABORATORY OSCILLOSCOPES	204
PORTABLE OSCILLOSCOPES	300
AUTOMATED TEST SYSTEMS INSTRUMENTS	353
DIGITIZERS/SOFTWARE/DIGITIZING CAMERA SYSTEM	354
SYSTEM SUPPORT/CONTROLLERS	392
ACQUISITION/PROCESSING PACKAGES	400
CURVE TRACERS	406
SIGNAL ROUTING INSTRUMENTS	420
MODULAR TEST AND MEASUREMENT INSTRUMENTS	434
CAMERAS, PHOTOMETER/RADIOMETER	476, 497
CARTS, PROBES, ACCESSORIES	502

A

A to D Converter 429
AC RMS Digital Voltmeters .... Portables 320
Modular Instruments .. 441
Accessories
Cables 532
Converter Probes ..... 11000 Series 223,496
GPIB Cables 23
Optical Electrical Converter
Probes ..... 11000 Series 223,496
Probes 505
Sampling ..... 7000 Series 278
Spectrum Analyzer 202
Viewing 535
Accessory Power Supply 1101A 520
Acquisition/Processing
Packages MP Packages 400
Adapters
BNC, BSM, Cable Input, F, GR, N,
Probe, Probe Grounding, Rack,
SMA (3 mm) 532
Camera Mounting 486
Curve Tracer 418
Fiber Optic 155
Socket 418
Agreements, Maintenance 537
Air Line, GR 532
Amplifiers
Current Probe 461,525
Differential ..... 7000, 5000 Series
Modular Instruments .. 269,297,461
Differential Comparator ..... 11000, 7000 Series 241,268
Dual Trace 11000, 7000, 5000
Series 240,264,291
Dual Trace Differential ..... 5000 Series 298
Four Trace ..... 11000, 5000 Series 240,296
Logic Triggered Vertical ..... 7000 Series 266
Operational ..... Modular Instruments .. 461
Programmable ..... 7000 Series 381,383
Single Trace 11000, 7000, 5000
Series 238,264
296
Waveform Digitizer ..... 5000, 7000 Series 295, 370
Analyzers
Audio ..... Modular Instruments .. 454
Data 105
Data Communications ..... 800 Series 159
Distortion ..... Modular Instruments .. 454
Logic ..... DAS 9200/9100, 1200,
300 Series 106-127
Spectrum ..... 2700, 490, 7000 Series 164-200
Television Sideband 1405 201
Application Notes
Photo/Radiometer 501
Portable Oscilloscopes 302
Probes 475
7000 Series Oscilloscopes 247
5000 Series Oscilloscopes 289
Attenuators
BNC, GR, N, SMA (3 mm) 532
Audio Products 151-152
Analyzers ..... Modular Instruments .. 454
Aural Modulation Monitor/Decoder 151
Channel Kit 143
Stereo Monitor 152
Sweep Generator ..... Modular Instruments .. 454,458
Synchronizer 118-AS 143
Test System, Programmable ..... Modular Instruments .. 454
Vector Converter 152
Automated Layout System ..... Software 90
Automated Test Equipment .... Systems 134
Digitizers, MP Packages 354,400
Automatic Frequency
Measurement ..... 11000 Series, Portables . 222,303
Automatic Period, Pulsewidth
and Time Measurements ..... 11000 Series, Portables . 222,303
Automatic Video Corrector 1440 144
Avionics Display 36

B

Battery Operated Oscilloscopes Portables 300
Battery Pack 332
Battery Power Supply 333
Bistable Storage Oscilloscopes 7000, 5000 Series,
Portables, Modular 258,290
Instruments 346,462
Blank Panel Plug-In Chassis 474
BNC, BSM Accessories 532

C

Cabinets, Plug-In Storage 534
Cable Input Adaptors 532
Cable Testing, Fault Locating
Fiber Optic Bandwidth Test Set 156
Fiber Optic TDR Testers ..... Portable 155
Metallic TDR Testers ..... Portable, 7000 Series .. 157,281
Cables
BNC, BSM, GR, N, SMA (3 mm) 532
CAE Systems 84
Calibration Generators ..... Modular Instruments .. 465
Calibration, Oscilloscope ..... Modular Instruments .. 465
Calibration and Other Services 537
Cameras
Carrying Cases 495
Digitizing 390,476
Hand-Held 488
Motorized Back 490
Mounting Adapters 486
Writing Speed Enhancer 480
Scope/CRT Display 475-495
Capacitors, Coupling 533
Cards
Programmable A/D Converter 429
Programmable D/A Converter 429
Programmable Development 432
Programmable Digital Input/Output 429
Programmable Memory 431
Programmable Relay Scanner 430
Carrying Cases
Camera 495
Plug-In 202,535
Carts
Lab/Portable Instruments 502
Workstation 79
Chassis, Blank Panel Plug-In 474
Circuits 32-35
Bipolar Analog IC 32
QuickChips 32
FullCustom 32
Hybrid 34
Circuit Boards 29
Printed Multilayer 29
Flexible 30
Teflon 30
Color Digital Analysis Mainframe DAS 9200/9100 Series . 106-117
Color Display/Graphics Products
Applications Systems ..... 4000 Series 51
Graphics Copiers ..... 4600 Series 73
Graphics Terminals ..... 4000 Series 53
Hard Copy Units ..... 4600 Series 73
Graphic Input Workstation 77
Output Systems 73
Software 69
Supplies 78

Tablets ... 77
Television Picture Monitors ... 650 Series ... 154
Workstations and Terminals ... 57
Communications Test Equipment
Analyzers
Data ... 159
Sideband ... 201
Spectrum ... 2700, 490, 7000 Series ... 162
Audio Products ... 152
Cable Fault-Locators ... 155
Demodulators ... 1450 Series ... 153
Frequency Counters ... 7000 Series ... 276
Modular Instruments ... 436
Generators, Audio Sweep ... Modular Instruments ... 458
Noise Measurement Set ... 144
Synchronizers ... 143
TV Oscilloscopes ... Portables ... 303,358
Vectorscopes ... 1700, 500 Series ... 147,150
VITS Inserters ... 148 Series ... 144
Waveform Monitors ... 1700, 1480 Series ... 145,150
Camera and Mounting Adapters ... 483
CRT Phosphor Data ... 209
CRT Storage Oscilloscopes ... 212
Digital Storage Oscilloscopes and Waveform Digitizers ... 354
Digital Counters ... 436
Digital Multimeters ... 441
Digital Photometer/Radiometer ... 497
Digitizers ... 354
Function Generators ... 444
Logic Analyzers ... 105
Modular Nonstorage Oscilloscopes ... 210
Modular Storage Oscilloscopes ... 258
Oscilloscope Calibration Products ... 465
Oscilloscope Cameras ... 475
Portable Nonstorage Oscilloscopes ... 210,301
Portable Oscilloscopes ... 300
Portable Storage Oscilloscopes ... 346
Power Supplies ... Modular Instruments ... 452
Probes ... 505
Pulse Generators ... 450
TM 500 Oscilloscopes ... 462
7000 Series Oscilloscopes ... 243
5000 Series Oscilloscopes ... 287
11000 Series ... 222
Components
Foundry, Design and Prototyping Services ... 32
Component Television ... 138
Component TV Generator ... 145
Computer Aided Engineering ... 84
Computer Aided Software Engineering ... 91
Computer Controlled Oscilloscopes ... MP Series ... 400
Computer Graphics Products (See Color Display/Graphics Products)
Computer Graphics Supplies ... 78
Connector Accessories ... 532
Controller-Based Acquisition/ Processing Measurement Packages ... MP Packages ... 400
Controller, Programmable Switch ... 433
Controllers, System ... 393
Constant Amplitude Generator ... Modular Instruments ... 467
Converters
A to D ... 429
D to A ... 429
Electrical/Optical ... 156,469
Optical/Electrical ... 156,469
Copiers
Color Graphics ... 4600 Series ... 73
Imaging Hard Copies ... 4600 Series ... 73
Video Hard Copies ... 4600 Series ... 73
HC Series ... 478
Cords, Patch ... 532
Corrector, Automatic Video ... 144
Counters, Digital
Frequency ... 11300, 7000 Series ... 226,276
Modular Instruments ... 439
Time Interval ... 11300, 7000 Series ... 226,276
Modular Instruments ... 439
Universal ... 11300, 7000 Series ... 226,276
Modular Instruments ... 439
Counter/Timer ... Modular Instruments ... 439
Counter/Timer Oscilloscope ... 11300 Series ... 226
Counter/Timer/DMM Oscilloscope ... Portables ... 303,320
341
Coupling Capacitors ... 533
Covers, Protective ... 534
Cradle Mount ... 534
CRT
Avionics ... 36
Custom Design ... 36
Light Filters, Mesh Filters ... 535
Monochrome ... 36
Readout Oscilloscopes ... 11000, 7000, 5000 Series Digitizers, Portables ... 203
Touch Panel ... 37
CRT Displays (see Displays)
Current Measuring Equipment ... Modular Instruments ... 441
Current Probe Amplifier ... 461,525
Current Probes ... 461,525
Curve Tracers
Adapters ... 418
Integrated Circuit ... 416
Programmable ... 406
Semiconductor ... 406
Customer Support ... 537
Customer Service Training ... 542

D

D to A Converter ... 429
Data Acquisition Modules ... 103,115
Data Acquisition Probes ... 130-133
Data Acquisition Packages ... MP Packages ... 400
Data Analyzers ... 105
Data Comm Analyzers, Testers ... 800 Series ... 159
DC Inverter ... 333
Delayed Sweep Oscilloscopes ... 11000, 7000, 5000 Series, Portables, Digitizers ... 222,248 287,300 354
Delayed Sweep Sampling Plug-In ... 7000 Series ... 280
Delaying Time Bases ... 7000, 5000 Series ... 270,273 280,292
Demodulators, Television ... 153
Designer's WorkSystem ... Software ... 85
Desktop Controller-Based Acquisition/Processing Packages ... MP Packages ... 400
Development Instruments, Digital ... DAS 9100, 9200, 1200, 300 Series ... 105
Development Unit, Multiuser Software ... 92
Differential Amplifiers ... 7000, 5000 Series ... 269,297
Modular Instruments ... 461
Differential Comparator Amplifier ... 11000, 7000, 5000 Series ... 241 268
Differential Input Oscilloscope ... 11000, 7000, 5000 Series, Digitizers ... 222,243 287,354
Differential Amplifier, Dual Trace ... 5000 Series ... 298

Differential Probes 242,268,269, 505,517

Digital Products
Analysis Mainframes . . . . . DAS 9200/9100 Series . 106-117
Counters . . . . . 7000 Series 276
Modular Instruments . . 436
Delay 449
Delay Oscilloscope . . . . . Portables, Digitizers . . . 320,354
Development Instruments . . . . . DAS 9200/9100, 1200, 300 Series 103
Generator/Inserter 142
Input/Output Card 429
Latches 106
Multimeters
Autoranging . . . . . Portables 341
Oscilloscope Coupled w/Temp . Portables 303,347
DMM Oscilloscope . . . . . Portables 303,316, 320,347
Photometer/Radiometer 497
Prescaler . . . . . Modular Instruments . . 440
Readout Oscilloscope . . . . . 11000, 7000, 5000 Series, Portables 222,243, 287,300
Storage Oscilloscopes . . . . . Digitizers 222,243, 300,354
Storage Spectrum Analyzers . . . . . 7000 Series 198
Tester . . . . . 800 Series 159
Voltmeters . . . . . Modular Instruments . . 441
Digitizers 354
Digitizer Time Bases . . . . . 7000, 5000 Series 383,389
Digitizing Camera Systems 390,476
Digitizing Oscilloscopes . . . . . Digitizers 222,243, 300,354
Disk Drive Unit 394
Display Monitors . . . . . GMA, 600 Series 38,41
Displays (CRT)
Color Television Picture 154
Color Display . . . . . 4000 Series 53-68
High Brightness 40
High Resolution 38-41
Large Screen 38
OEM 38-41
Raster Scan, Video 38-41
Television Waveform 146
Vector Display 147
X-Y 41
Distortion Analyzers . . . . . Modular Instruments . . 457
DMM Oscilloscopes . . . . . Portables 303,316, 320,347, 368
Dual Beam Oscilloscopes . . . . . 7000, 5000 Series 256,293
Dual Beam Storage Oscilloscopes . . . . . 5000 Series 293
Dual Time Base (Mixed Sweep) 7000, 5000 Series 272,274, 299
Dual Trace Amplifiers . . . . . 11000, 7000, 5000 Series 240,265, 291
Dual Trace Differential Amplifier 5000 Series 298
Dual Trace Digital Storage Oscilloscope . . . . . Portables, 11000 Series 222,354
Dual Trace Oscilloscopes . . . . . 11000, 7000, 5000 Series 226,248, 291
Digitizers, Portables . . . 300,354
Modular Instruments . . 462
DUT Interfacing Products 420

E

Educational Products and Materials 334-340
Electronic Components 28
Enclosures, Metal 31
Extender, Multifunction Interface 428

F

F Adapters 533
Fast Rise Pulse Generator . . . . . 7000 Series 286
Modular Instruments . . 450
Fast Transfer Storage Oscilloscopes . . . . . Portables 346
Fault Locating Cable Testing 155
FET Probes 505,519
Fiber Optic Adapter 155
Fiber Optic Bandwidth Test Set 156
Fiber Optic Cable Testers 155
Fiber Optic Electrical/Optical Optical/Electrical Converters 156,469
Filters
Bandpass/Amplifier . . . . . Modular Instruments . . 434
CRT Light, CRT Mesh 535
Floating Measurements (Isolated) 527
Foundry Services 32
Four Trace Amplifiers . . . . . 11000, 5000 Series 241,296
Four Channel Oscilloscopes . . . Portables 303,358
Frequency Counters . . . . . 11300, 7000 Series 226,276
Modular Instruments . . 436
Frequency Measurements, Automatic . . . . . 11000 Series, Portables 222,303
Full Custom WorkSystem . . . . . Software 88
Function Cards 424
Function Generators . . . . . Modular Instruments . . . 444
Furniture, Workstation 79

G

Gate Array Layout WorkSystem Software 87
Generators, Signal
Audio Sweep . . . . . Modular Instruments . . . 458
Calibration . . . . . Modular Instruments . . . 465
Component TV 145
Constant Amplitude . . . . . Modular Instruments . . . 464
Fast Rise Pulse . . . . . Modular Instruments . . . 450
Function . . . . . Modular Instruments . . . 444
High Frequency . . . . . Modular Instruments . . . 467
NTSC 141
PAL and PAL-M 140
Pulse . . . . . Modular Instruments . . . 450
Ramp . . . . . Modular Instruments . . . 444
Rate/Ramp . . . . . Modular Instruments . . . 444
RC Oscillator . . . . . Modular Instruments . . . 468
Sine Wave . . . . . Modular Instruments . . . 468
Square Wave . . . . . Modular Instruments . . . 444
Television Sync . . . . . 1400 Series 141
Television Test 141-143, 145
Time-Mark . . . . . Modular Instruments . . . 467
Tracking 201
Triangle . . . . . Modular Instruments . . . 444
Video Noise 144
GPIB Products
A to D Converter 429
Acquisition/Processing Packages . MP Packages 400
Audio Test System . . . . . Modular Instruments . . . 458
Cables 23

Calibration Generator . . . Modular Instruments . . 466
Controller-Based Acquisition/
Processing Measurement Packages . MP Packages . . . 400
Controllers . . . 392
Counter/Timers . . . Modular Instruments . . . 436
Curve Tracers . . . 406
D to A Converter . . . Modular Instruments . . . 429
Desktop Controller-Based Acquisition/
Processing Measurement Packages . MP Packages . . . 400
Digital Multimeter . . . Modular Instruments . . . 441
Digital Storage Oscilloscope . . . Digitizers . . . 353
Digitizers . . . 353
Digitizer Packages . . . MP Packages . . . 400
Digitizing Camera System . . . 390,476
Digitizing Oscilloscopes . . . 353
Distortion Analyzer . . . Modular Instruments . . . 454
DUT Interfacing Products . . . TSI 8150 Series . . . 420
Modular Instruments . . 428
Logic Analyzer . . . 105
Multiplexer . . . Modular Instruments . . . 433
Power Supplies . . . Modular Instruments . . . 452
RF Scanner . . . Modular Instruments . . . 432
Software . . . 374,397, 398

Spectrum Analyzers . . . 2750, 490 Series . . . 163
Waveform Processing Oscilloscopes . 7000 Series, Digitizers . . 353
GPIB Reference . . . 14
GR Accessories . . . 532
Graphics Products, Computer
(see Color Display/Graphics Products)
Ground Adapters, Probe . . . 532
Ground Isolation Monitor . . . 527
Ground Leads, Probe . . . 532

H

Hand-Held Camera . . . 488
High Brightness Monitor . . . 40
High Current Probe . . . 526
High Current Transformer . . . 533
High Frequency Oscilloscopes . 11000, 7000 Series, . . . 222,243
Portables, Digitizers . . . 300,353
High Frequency Signal Generators Modular Instruments . . . 450
High Gain Oscilloscopes . . . 11000, 7000, 5000
Series . . . 222,243, 287

High Resolution Copier . . . 73-77
High Resolution Monitor . . . 40
High Voltage Probe . . . 443,508
518,527

Hoods, Viewing . . . 535
Housing Accessory, BNC . . . 532
Hybrid Components . . . 28

I

Image Forming Module . . . 77
Incoming Inspection Test Station . MP Packages . . . 400
Input Adapters, Cable . . . 532
Input/Output Card, Digital . . . Modular Instruments . . . 429
Inserters, VITS . . . 142,144
Instrument Carts, Mobile . . . 502
Instrumentation, Programmable (see GPIB Products)
Instrumentation Packages . . . MP Packages . . . 400
Instruments, Digital
Development . . . DAS 9200/9100, 1200,
300 Series . . . 105
Integrated Circuit Curve Tracer . . . 416
Integrated Circuit Test Equipment . . . 134
Integrated Circuits
Quick Chip . . . 32
Microlithography/Design . . . 33
Integrated Counter/Timer/DMM
Oscilloscope . . . Portables . . . 320
Intelligent Graphics Workstations . . . 67

Interface Extender, Multifunction . Modular Instruments . . . 428
Interface, Programmable . . . TSI 8150 Series . . . 421
Multifunction . . . Modular Instruments . . . 428
Interface, Touch Panel . . . 37
Inverter, DC . . . 333
Isolated (Floating)
Measurements . . . 527,528

L

Lab/Portable Instrument Carts . . . 502
Leads, Patch Cord . . . 532
Leads, Probe Ground . . . 532
Library, Graphics Software . . . 71
Light Filters, CRT . . . 535
Light Measurement . . . 497
Logic Analyzers . . . DAS 9200, 9100, 1200,
300 Series . . . 103-127
Logic Probe . . . 130
Logic Triggered Vertical
Amplifier . . . 7000 Series . . . 266
Low Frequency Oscilloscopes . 5000 Series, Portables . 293,326
Digitizers . . . 350-352,364

M

Mainframes
Color Digital Analysis . . . 105
General Purpose Instruments . . . Modular Instruments . . . 470
Logic Analyzer . . . 1200 Series . . . 118
Maintenance Agreements . . . 537-541
Matrix, Switch . . . Modular Instruments . . . 433
MERLYN-G . . . Software . . . 84
MERLYN-PCB . . . Software . . . 84
Mesh Filters, CRT . . . 535
Metallic Cable Testers . . . 1500 Series, 7000 . . . 157,281
Metal Products . . . 31
Microprobes . . . 506
Microprocessor Support
CASE . . . 91
Logic Analyzers . . . 105
Microwave, Spectrum Analyzers . . . 162
Military Designator Oscilloscopes Portables . . . 325
Millimeter Wave,
Spectrum Analyzers . . . 165
Mixed Sweep (Dual Time Base)
Oscilloscopes . . . 7000, 5000 Series . . . 272,274, 299

Mixers, Waveguide . . . 191
Modular Probes . . . 505
Modules, Data Acquisition . . . 105
Module, Image Forming . . . 77
Monitors
BTSC Aural Modulation/Decoder . . . 151
Color Television Picture . . . 154
Color Display . . . 49
Computer Display . . . 49
High Brightness . . . 40
High Resolution . . . 40
Large Screen . . . 38
Nonstorage . . . 40
OEM . . . 38-41
Raster Scan, Video . . . 38-41
Stereo Audio . . . 152
Storage Display . . . 38-41
Television Waveform . . . 146-150
Vector Display . . . 146-150
XY . . . 38-41
Motorized Back Camera . . . 490
Mounting Adapters, Camera . . . 486
Mounting Dimensions and
Adapters . . . 534
Multimeters, Digital (see Digital Multimeters)
Multimode Storage
Oscilloscope . . . 7000 Series, Portables . 210,258,346

Multiplexer . . . . . Modular Instruments . . . 433

N

N Connector Cables and Adapters 532
Network Analyzers 159
Noise Generator, Video 144
Noise Measurement Set, Television 144
NTSC Generators 142

O

OEM Products 38-41,51, 77,480
Operational Amplifier . . . . . Modular Instruments . . . 461
Oscillators . . . . . Modular Instruments . . . 454,458,468
Oscilloscope Amplifiers
(see Plug-in Units)
Oscilloscope Calibration Equipment . . . . . Modular Instruments . . . 465
Oscilloscope Cameras 480
Oscilloscope Carts 502
Oscilloscopes
Battery Operated 300
Classroom/Lab 334
Computer Controlled . . . . . MP Package 400
Counter/Timer/DMM . . . . . Portables 303,320,347
Counter/Timer/Trigger . . . . . Portables 303,320
Coupled with Temperature . . . . . Portables 347
CRT Readout . . . . . 11000, 7000, 5000 Series Portables, Digitizers 222,243, 248,258, 290,303, 368
Curve Tracers 406
Data Analyzer 106
Delayed Sweep . . . . . 11000, 7000 Series, ... Portables, Digitizers 222,248 270,273 280,283, 287,290, 292,300, 353,372
Differential Input . . . . . 11000, 7000, 5000 Series 222,248, 287,354
Digital Delay . . . . . 7000 Series, Digitizers . . 248,372,449
Digital Readout . . . . . 11000, 7000, 5000 Series . . . . . Portables, Digitizers 222,372, 290,303, 341,347, 368
Digital Storage . . . . . 11000, 7000 Series . . . . Portables, Digitizers . . . 222,233 301,355, 358,364, 368,372,387
Digitizing . . . . . 11000 Series 222
DMM . . . . . Portables 303,316, 320,347,368
Dual Beam . . . . . 7000, 5000 Series 256,293
Dual Trace . . . . . 11000, 7000, 5000 Series . . . . . Portables, Digitizers 248,287, 287,303, 341,345,372
Modular Instruments . . . 464
Dual Trace Digital . . . . . 11000 Series, Portables . 222,268
Eight Channel . . . . . 11000 Series 222
Four Channel . . . . . 11000 Series, Portables . 222,303
High Frequency . . . . . 11000, 7000 Series . . . . Portables, Digitizers 222,243 300,353
High Gain . . . . . 11000, 7000, 5000 Series 222,243,287
Low Frequency . . . . . 5000 Series, Portables . 293,326 350,364
Modular Instruments . . . 464
Military Designator AN/USM-488 . Portables 325
Mixed Sweep (Calibrated) . . . . . 7000, 5000 Series 272,274
Portables 299
Nonplug-in . . . . . Portables 300
Plug-in . . . . . 11000, 7000, 5000 Series 222,243
Modular Instruments . . . 287,462
Portable 300
Programmable . . . . . 11000, 7000 Series 222,243
Rackmount . . . . . 7000, 5000 Series 248,258
Portables 290,293, 303,315, 319,324
Modular Instruments . . . 462,470
Ruggedized . . . . . Portables 325
Sampling Plug-in . . . . . 7000 Series 278-286
Storage
Bistable . . . . . 7000, 5000 Series 258,290
Portables 346
Modular Instruments . . . 462
Digital 222,233, 301,355, 358,364, 368,372, 387
Dual Beam . . . . . 7000, 5000 Series 261,293
Fast Transfer . . . . . Portables 346
Multimode . . . . . 7000 Series, Portables . 203,258 346
Reference Information 203,222,243 287,301
Variable Persistence . . . . . 7000, 5000 Series 258,290
Portables 346
Television . . . . . Portables 301,346,358
Modular Instruments . . 462
Waveform Processing . . . . . 11000 Series 222
MP Packages 400
Word Recognizer . . . . . Portables 303,346
X-Y Plotting . . . . . 7000, 5000 Series 248,287
Portables 326,341
Modular Instruments . . . 462

P

PAL and PAL-M Generators 142
Panel Plug-In Chassis, Blank 474
Patch Cords, Leads 532
Pattern Generator Probes/ Modules 106
PCB WorkSystem . . . . . Software 84
Performance Analysis (Software and Hardware) 118
Period, Pulse, Width and Time Measurements, Automatic . . . . . 11000 Series, Portables . 222,303, 358
Photometer/Radiometer, Digital 497
Plotter 478
Plug-Ins
General Purpose Instruments . . . . Modular Instruments . . . 434
Oscilloscope . . . . . 11000, 7000, 5000 Series 238,264, 291,292, 295,296
Plug-In Carrying Cases 202,535
Plug-In Chassis, Blank Panel 474
Plug-In Storage Cabinets 534
Plug-In Units
AC RMS Digital Voltmeter . . . . . Portables 320
Modular Instruments . . . 441
Calibration Generators . . . . . Modular Instruments . . . 465
Current Probe Amplifier . . . . . Modular Instruments . . . 461
Curve Tracers 406
Delayed Sweep Sampler . . . . . 7000 Series 280

Delaying Time Bases ..... 7000, 5000 Series 270,273, 280,292
Differential Amplifiers ..... 7000, 5000 Series 268,297
Modular Instruments ... 461
Differential Comparator Amplifier . 11000, 7000, 5000 Series 222,241, 268,297
Digital Counters ..... 7000 Series 276
Modular Instruments ... 436
Digital Delay ..... Modular Instruments ... 449
Digital Multimeters ..... Modular Instruments ... 441
Digital Prescaler ..... Modular Instruments ... 440
Digitizer Time Bases ..... 7000, 5000 Series 383,389
Dual Differential Amplifier ..... 5000 Series 298
Dual Time Base (Mixed Sweep) .. 7000, 5000 Series 272,274,299
Dual Trace Amplifiers ..... 11000, 7000, 5000 Series 240,265,291
Dual Trace Differential Amplifiers . 5000 Series 298
Four Trace Amplifiers ..... 11000, 5000 Series 241,296
Logic Triggered Vertical Amplifier . 7000 Series 266
Operational Amplifier ..... Modular Instruments ... 461
Oscillators ..... Modular Instruments ... 467,468
Oscilloscopes ..... 11000, 7000, 5000 Series 238,264, 291,292 295,296
Modular Instruments ... 462
Power Supplies
0 to 20 V Variable ..... Modular Instruments ... 452
for Plug-In Units ..... Modular Instruments ... 452
Programmable ..... Modular Instruments ... 452
Programmable ..... 7000 Series 370,381,389
Programmable Distortion Analyzer Modular Instruments ... 454
Ramp Generator ..... Modular Instruments ... 444,445
Rate/Ramp Generator ..... Modular Instruments ... 444,445
RF Sweep Generator ..... Modular Instruments ... 467
Sampling ..... 7000 Series 278-286
Sampling Heads ..... 7000 Series 283-286
Single Time Bases ..... 7000, 5000 Series 270,273
Single Trace Amplifier ..... 11000, 7000, 5000 Series 238,264,296
Spectrum Analyzers ..... 7000 Series 198-200,277
TDR ..... 7000 Series 281
Tracking Generators 201
Universal Counter/Timers ..... 7000 Series 276
Modular Instruments ... 436

Polarized Viewers 535
Portable Products
Acquisition/Processing
Measurement Package 400
Data Communication Analyzers 159
Fiber Optic Cable Testers 155
Logic Analyzers 105
Metallic Cable Testers 157
Oscilloscopes 300
w/Counter/Timer/Trigger 303,320
w/DMM, Temp 347
Oscilloscope Power Supply 332,333
Spectrum Analyzer ..... 2750, 490 Series 164,178
Power Divider, GR and SMA (3mm) 533
Power Supplies
0 to 20 V Variable ..... Modular Instruments ... 452
Accessory 520
Battery 333
for Plug-In Units ..... Modular Instruments ... 452
Portable Oscilloscope 332,333
Programmable ..... Modular Instruments ... 452
Prescaler, Digital ..... Modular Instruments ... 440
Printed Circuit
Design System 29
Design and Manufacturing 29

Probes
Accessories 529
Active 519
Adapters 532
Amplifiers, Current ..... Modular Instruments ... 461
Chart, Recommended 508
Counter 513
Current 523
Data Acquisition 130-133
Differential 242,505,527
Digital Photometer/Radiometer 497
Environmental 508,522
FET and 50 Ohm 508,519
Ground Leads 532
Grounding Adaptors 532
High Current 461,525
High Voltage 443,508, 518,527
Logic 130-133
Modular 508,511,512
Micro 506
Optical-Electrical Converter ..... 11000 Series 242,520
Pattern Generator 130-133
Recommendations 508-509
RF 443,522
Sampling 514
Temperature 443,522
Tips 529,530
Voltage 508-509
Word Recognizer 130-133,363
Programmable Instrumentation
(see GPIB Products)
Protective Covers 535
Pulse Generators ..... 7000 Series 286
Modular Instruments ... 450

R

Rack Adapters 535
Rackmount Model Instrument Carts 502
Rackmount Oscilloscopes ..... 11000, 7000, 5000 Series 248,258
Portables 290,293, 303,315, 319,324
Modular Instruments ... 462,470
Ramp Generators ..... Modular Instruments ... 444,445
Raster Scan Display Units 40
Rasterizer 75
Rate/Ramp Generators ..... Modular Instruments ... 444,445
RC Oscillator ..... Modular Instruments ... 468
Readout Oscilloscopes, CRT ... 11000, 7000, 5000 Series 222,243
Digitizers, Portables 248,258, 290,303 368
Readout Oscilloscopes, Digital . 11000, 7000, 5000 Series 222,290
Digitizers, Portables 303,341, 347,368, 372
Receivers, Optical/Electrical 156,267, 469
Reference Information
(see Selection Guides)
Acquisition/Processing 400
Camera Recommendations 483
CRT Phosphors 209
Digitizers 353
Display Technology Section 42
General Purpose Interface Bus 14

Modular and Integrated Oscilloscopes . . . 210
Oscilloscope Specifications . . . 206
Probe Recommendations . . . 508
Sales, Ordering, Customer Support . . . 536
Sampling Applications . . . 278
Storage Displays . . . 209
Waveform Digitizers . . . 215
Reflectometer Cable Testing, Time Domain . . . 155
RF Probe . . . 443,522
Ruggedized Oscilloscopes . . . Portables . . . 325

S

Safety (Isolators) . . . 527
Sampler, Delayed Sweep . . . 7000 Series . . . 280
Sampling Products
Accessories . . . 7000 Series . . . 278
Decision Tree . . . 278
Plug-In Units
Delayed Sweep . . . 7000 Series . . . 280
Heads . . . 7000 Series . . . 283
Probes . . . 514
Scanner, Programmable/Low Level . . . Modular Instruments . . . 430,432
Selection Guides
4200/4110 Series . . . 53
4310 Series . . . 67
4320/4220 Series . . . 63
4330/4230 Series . . . 60
11000 Series . . . 222
5000 Series . . . 287
7000 Series Oscilloscope Systems/Probe . . . 243
7000 Series Nonstorage . . . 248
7000 Series Storage . . . 258
Camera and Mounting Adapter . . . 483-485
Carts . . . 502
Digital Counters . . . 437-438
Digital Multimeter . . . 441
Function Generators . . . 445-446
Logic Analyzer . . . 105
Power Supplies . . . 452
Portable Real Time Oscilloscope . . . 301
Portable Storage Oscilloscope . . . 346
Probes . . . 508
Pulse Generators . . . 450
Spectrum Analyzers Products . . . 163
TM 500 Scopes . . . 463
Semiconductor
Automatic Test Equipment . . . LT 1000 . . . 134
MP Packages . . . 400
Curve Tracers . . . 406
Service Maintenance Contracts . . . 537
Service Training . . . 542
Servicing Aids, Digital . . . 449
Single Time Bases . . . 7000, 5000 Series . . . 270,273
Sideband Analyzers, Television . . . 201
Signal Generators
(See Generator, Signal)
Signal Pickoff . . . 533
Signal Routing Instruments . . . 420
Signal, TV Correctors . . . 144
Single Trace Amplifiers . . . 11000, 7000, 5000 Series . . . 238,264,296
SMA (3mm) Accessories . . . 532
Socket Adapters . . . 418
Software
Development WorkSystem . . . 84
Engineering, Computer Aided . . . 91
Life Cycle . . . 92
Summary . . . 26
Spectrum Analyzers
Accessories . . . 202
Digital Storage . . . 7000 Series . . . 198
Laboratory . . . 2750 Series . . . 164
Plug-In . . . 7000 Series . . . 198
Portable . . . 490 Series . . . 178
Programmable . . . 2750, 490P Series . . . 164-194
Software . . . 195
Waveguide Mixers . . . 191
Sweep Generator, Audio . . . Modular Instruments . . . 454
Swept Frequency Systems . . . 201
Switch Controller, Programmable . . . Modular Instruments . . . 433
Switch, Matrix . . . Modular Instruments . . . 433
Sync Generator, Television . . . 142
Synchronizers . . . 143
Systems
Acquisition/Processing . . . MP Packages . . . 400
Artificial Intelligence . . . 67
Automated Layout . . . 84
CAE . . . 84
Custom Test . . . 217
Data Acquisition . . . MP Packages . . . 400
Desktop Controller-Based . . . MP Packages . . . 400
Digitizing Camera . . . 390
Graphic . . . 57
Graphic Presentation . . . 77
Printed Circuit Board Design . . . 29
Programmable Audio Test . . . Modular Instruments . . . 454
Software . . . 26
Swept Frequency . . . 201
Technical Data Analysis . . . 216
Test and Measurement . . . Modular Instruments . . . 434
Digitizers, MP Packages . . . 354,400
TV Waveform Measurement . . . Portables . . . 301,346, 358
UNIX Software Development . . . 69
VLSI . . . 134

T

Technology Reference . . . 42
Television Products (see full description in Television Catalog)
Audio Synchronizer . . . 143
Automatic Video Correctors . . . 144
Color Picture Monitor . . . 154
Demodulators . . . 153
Oscilloscopes . . . 7000 Series, Portables . . . 274,301, 346,358
Sideband Analyzers . . . 201
Signal Correctors . . . 144
Sync Generators . . . 142
Synchronizers . . . 143
Test Signal Generators . . . 142,143, 145,153
Vectorscopes . . . 150
VITS Inserters . . . 142,144
Waveform Monitors . . . 150
Waveform/Vector Monitors . . . 150
X-Y Monitor . . . 154
Temperature Measurements . . . 522
Temperature Probe . . . 522
Terminals, Color Graphics Display . . . 4000 Series . . . 53
Terminals, Graphic Computer . . . 53
Terminations, BNC, GR, SMA (2 mm) . . . 532
Test and Measurement Systems Digitizers, MP Packages . . . 354,400
Modular Instruments . . . 434

Test and Measurement Software
WorkSystem . . . . . Software 84
Test Equipment, Communications
(see Communications Test Equipment)
Test Signal Generators 142,145, 153

Test Station, Incoming Inspection . . . . . MP Packages 400
Test Systems
Automatic 134
Programmable Audio . . . . . Modular Instruments . . . 454
VLSI 134
Testers
Digital 159
Fiber Optic Cable 155
Metallic Cable 157
Thermal Readout . . . . . Modular Instruments . . . 441
Portables 447
Three-Dimensional Displays . . . 4120 Series 57
Time Bases
Delaying . . . . . 7000, 5000 Series 270,273, 280,292
Digitizer . . . . . 7000, 5000 Series 383,389
Dual (Mixed Sweep) . . . . . 7000, 5000 Series 272,274, 299
Single . . . . . 7000, 5000 Series 270,273
Time Domain Reflectometer, Cable Testing 155
Time Interval Counters . . . . . 11300, 7000 Series 226,276
Modular Instruments . . . 436
Time Mark Generator . . . . . Modular Instruments . . . 467
Tips, Probe 529,530
Touch Panel, CRT 37
Trace Recording Cameras 480
Tracking Generators 201
Training 219,542
Training Tapes 340
Transformers, High Current 505,525
Transistor Curve Tracers 406
Transient Digitizer 379-386
Transmitters, Electrical/Optical 156,469
Triangle Generators . . . . . Modular Instruments . . . 444
Two-Dimensional Displays 57

U

Universal Counter/Timers . . . . . 11300, 7000 Series 226,276
Modular Instruments . . . 436

V

Vectorscopes . . . . . 1400, 500 Series 150
Video Products
Corrector, Automatic 144
Hard Copy Units 77,478
Interface Kit 143
Monitor, Raster Scan 40,154
Noise Generator 144
Viewing Hoods and Accessories 534
VITS Inserters . . . . . 1900 Series 142
VLSI Test Systems 134
Voltage Probes 508-509
Voltmeter, AC RMS Digital . . . . . Modular Instruments . . . 441
Portables 320

W

Warranty Programs 537
Waveform Digitizer Amplifier . . . 7000, 5000 Series 370
Waveform Digitizer, Programmable 379-386
Waveform Digitizing Instruments 353
Waveform Monitors . . . . . 1700, 1400 Series 146
Waveform Processing Oscilloscopes . . . . . 7000 Series, Digitizers . . 372,
MP Packages 400
Waveform/Vector Monitors 149,150
Waveguide Mixers 191
Window Managed Display 57
Windowing 57
Word Recognizer . . . . . Portables 303,358
Word Recognizer Probe 130-133
363
Workstation Furniture 79
WorkSystems
Designer's . . . . . Software 84
Full Custom . . . . . Software 84
Gate Array . . . . . Software 84
PCB . . . . . Software 84
Signal Processing . . . . . Software 84
Workstations
CAD/CAM 57
Color Graphics 51
Graphic Input 57
High Performance, 2D & 3D
Intelligent Graphics 57
Writing Speed Enhancers, Camera 480

X

X-Y Monitors 154

Type	Instrument Description	Page
AA 501	Distortion Analyzer	457
AA 5001	Programmable Distortion Analyzer	454
AnthroBench	Bench	82
AnthroCart	PC, GT Carts	79
AnthroArm	Shelf Arms	80
AM 501	Operational Amplifier	461
AM 502	Differential Amplifier	461
AM 503	Current-Probe Amplifier	461, 525
AN/USM-488	100 MHz Dual Trace Portable Oscilloscope	325
AVC-20	Audio Vector Converter	152
A6302	Current Probe	461, 525
A6303	Current Probe	461, 525
A6741	RS-499 Interface	160
A6742	2-Wire Direct Interface	160
A6743	Tri-State Break-Out Box	160
A6744	Interface Adapter	160
A6746	EBU/SMPTE Bus Interface	160
A6747	X.21 Physical Interface	160
A6901	Ground Isolation Monitor	527
A6902B	Isolator	528
CAE	Computer Aided Engineering	84
CDM250	Digital Multimeter	339
CFG250	Function Generator	340
CFC250	Frequency Counter	340
CG 5001	Programmable Oscilloscope Calibration Generator	466
CG 551AP	Programmable Oscilloscope Calibration Generator	466
CPS250	Power Supply	339
CRS10	Power Unit	336
CRS30	General Purpose Board	336
CRS50	Video Signal Board	337
CRS70	Digital Pattern Board	337
CRS72	Digital Fault Board	337
CRS90	Builder's Board	337
CT-1	Current Transformer	526
CT-2	Current Transformer	526
CT-3	Signal Pickoff	533
CT-4		526
C-30B	Camera	492
C-31B	Camera	492
C-4	Camera	488
C-5C	Camera	487
C-51	Camera	493
C-53	Camera	493
C-59A	Camera	493
C-7	Camera	491
DAS 9109	Digital Analysis Mainframe	115
DAS 9119	Digital Analysis Mainframe (ATE Version)	115
DAS 9129	Color Digital Analysis Mainframe	115
DAS 9219	Digital Analysis Mainframe	106
DAS 9229	Color Digital Analysis Mainframe	106
DAS 92E9	Expansion Mainframe	106
DAS 9200T	High Resolution Color Display	106
DCS01	Digital Camera System	390, 476
DC 5009	Programmable 135 MHz Universal Counter/Timer	439
DC 5010	Programmable 350 MHz Universal Counter/Timer	439
DC 503A	125 MHz Universal Counter	440
DC 504A	100 MHz Counter/Timer	439
DC 509	135 MHz Universal Counter/Timer	439
DC 510	350 MHz Universal Counter/Timer	439
DD 501	Digital Delay	449
DM 44	Digital Multimeter	349
DM 501A	Digital Multimeter	442
DM 5010	Programmable Digital Multimeter	442
DM 502A	Autoranging Digital Multimeter	442
DP-100	Digital Video Probe	140
DP 501	Digital Prescaler	440
ECO-170A	Synchronous Changeover	141
E Systems Micro-controller	68HC11	99
FG 501A	2 MHz Function Generator	448
FG 5010	Programmable 20 MHz Function Generator	447
FG 502	11 MHz Function Generator	448
FG 503	3 MHz Function Generator	447
FG 504, FG 504T	40 MHz Function Generators	447
FG 507	2 MHz Sweeping Function Generator	447
GMA201	Computer Display Monitor	38
HC01	Video Copier	478
HC02	Video Copier	478
HC100	Plotter	479
J16	Digital Photometer/ Radiometer	497
J6501	Illuminance Probe	500
J6502	Irradiance Probe	500
J6503	8° Luminance Probe	500
J6504	Uncorrected Probe	500
J6505	LED Probe	500
J6511	Illuminance Probe	500
J6512	Irradiance Probe	500
J6523	1° Luminance Probe	501
K212	Portable Instrument Cart	503
K213	Lab Instrument Cart	504
K217	Rack Instrument Cart	504
LANDS	Language Development Systems	95
LT-1000	VLSI Logic Test System	135
MERLYN-G	Automated Layout System	90
MERLYN-PCB	Printed Circuit Board Design System	90
MI 5010	Programmable Multifunction Interface	428
MP 1101	Programmable Digitizer Measurement Package	401
MP 1201	Programmable Digitizer Measurement Package	401
MP 1701	Acquisition/Measurement/ Viewing Package	403
MP 2101	Acquisition/Processing Measurement Package	401
MP 2201	Acquisition/Processing Measurement Package	401
MP 2501	Acquisition/Processing Measurement Package	402
MP 2601	Portable Measurement Package	403
MP 2701	Acquisition/Measurement/ Viewing/Analysis Package	403
MP 2901	Inspection Test Station	404
MP 2902	Audio Measurements Package	405
Multi-V Systems	Microprocessor Support	98
MX 5010	Interface Extender	428
OF150	Fiber Optic TDR	155
OF152	Fiber Optic TDR	155
OF192	Fiber Optic Bandwidth Test Set	156
OF235A	Fiber Optic TDR	155
OR501	Receivers	156
OR502	Receivers	156
OT501	Transmitters	156
OT502	Transmitters	156
OT503	Transmitters	156
PC-05	Terminal Emulation Software	52
PC-07	Terminal Emulation Software	52
PC4100	Coprocessor Board	51
PCD13	Color Graphics Monitor	52
PEP 301	System Controller	392
PG 501	50 MHz Pulse Generator	451
PG 502	250 MHz Pulse Generator	451
PG 506	Calibration Generator	467
PG 507	Dual Output 50 MHz Pulse Generator	451
PG 508, PG508T	50 MHz Pulse Generators	451
PS 5004	Power Supply	453
PS 5010	Programmable Triple Power Supply	453
PS 501-1	Power Supply	451
PS 503A	Triple Power Supply	453
P6006	10X Probe	511
P6007	100X Probe	518
P6008	10X Probe	515
P6009	100X Probe	518
P6015	1000X Probe	518
P6021	Current Probe	524
P6022	Current Probe	524
P6028	1X Probe	511
P6041	Data Acquisition Probe	132
P6046	FET Differential Probe	521
P6048	10X Probe	515
P6053B	10X Probe	514
P6055	10X Probe	521
P6056	10X Probe	515
P6057	100X Probe	515
P6062B	10X or 1X Probe	514
P6063B	10X or 1X Probe	514
P6101A	1X Probe	512
P6102A	10X Probe	512
P6103	10X Probe	513
P6105A	10X Probe	512
P6106A	10X Probe	512
P6107A	10X Probe	512
P6108A	10X Probe	512
P6109	10X Probe	513
P6121	10X Probe	513
P6122	10X Probe	513
P6125	5X Counter Probe	513
P6130	10X Probe	516
P6131	10X Probe	516
P6133	10X Probe	516
P6134	10X Probe	242, 517
P6135	10X Probe	242, 517
P6136	10X Probe	516
P6149A	10X Probe	512

Color identifies *NEW* products

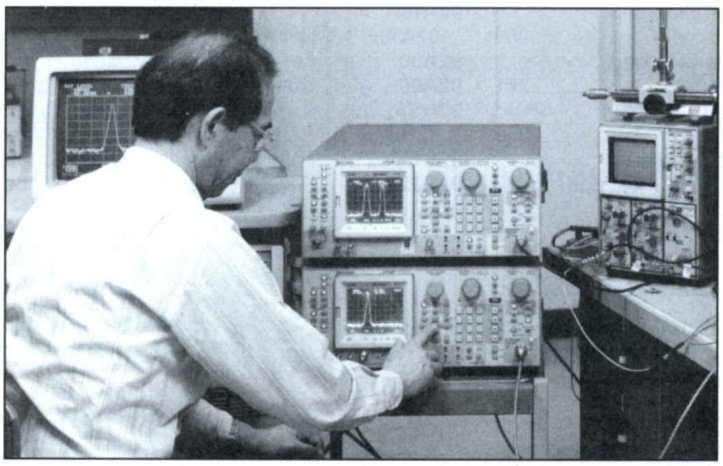
Type	Instrument Description	Page
P6201	FET Probe	519
P6202A	FET Probe	519
P6230	10X Probe	520
P6231	10X Probe	242, 520
P6302	Current Probe (See A6302)	461, 525
P6303	Current Probe (See A6303)	461, 525
P6401	Logic Probe	132
P6406	Word Recognizer Probe	132
P6407	Word Recognizer Probe	132
P6420	1X RF Probe	132
P6451	Data Acquisition Probe	132
P6452	Data Acquisition Probe	132
P6453	High-Speed Data Acquisition Probe	132
P6454	100 MHz Clock Probe	132
P6455	TTL/MOS Pattern Generator Probe	132
P6456	ECL Pattern Generator Probe	132
P6457	Pattern Generator Probe	132
P6460	Data Acquisition Probe	132
P6461	Data Acquisition Probe	132
P6462	Data Acquisition Probe	132
P6464	Data Acquisition Probe	132
P6465	Data Acquisition Probe	132
P6501	Microprobe	506
P6507	Microprobe	507
P6601	Temperature Probe	443
P6602	Temperature Probe	522
P6701	Optical-Electrical Converter	496
P6702	Optical-Electrical Converter	496
P6751	Spatial Input Head	506
RSM	Remote Site Monitoring Software	195
RTD 710	Digitizer	384
SC 501	5 MHz Oscilloscope	464
SC 502	15 MHz Dual Trace Oscilloscope	464
SC 503	10 MHz Storage Oscilloscope	464
SC 504	80 MHz Oscilloscope	464
SF4208	Industrial Color Graphics Terminal	56
SG 502	RC Oscillator	468
SG 503	Leveled Sine-Wave Generator	467
SG 504	Leveled Sine-Wave Generator	467
SG 505	Oscillator	458
SG 5010	Programmable Oscillator	454
SI 5010	Programmable Scanner	432
SOFTWARE		
ASYST	Software	376
Common LISP	(4400P33) Software	69
EMI	(S26EM00) Software	195
GRASP	(S26RF00) Software	195
GURU II	Software	398
ICOM40A	Interface Software	95
Instrument Software Library		399
LANDS	Language Development Systems	95
PLOT 10	Graphics Software Library	71
QUINTUS PROLOG	Software	70
SD Tools	TekCASE Designer	94
Small-talk-80	Software	69
SPD	(10Z210) Signal Processing Display	378
Tek EZ-TEST	Software	397
TekMAP	(062-7732-00) 7D20/4041 Time and Amplitude	374
S3FG120	GPIB Interface	398
S3FG121	GPIB BASIC Interface	398
S3FG122	GPIB C Compiler Interface	398
S42P101	7854/IBM PC	375
S42P201	7D20/IBM PC	375
S42H201	7D20/HP Series 200	375
S42H202	7854/HP Series 200	375
TekSPANS	Software	195
UNIX EMAC Editor	(440P32) Software	70
92DV	ASIC Prototype Verification Software	111
SPG12	TV Sync Generator	142
SPG170A	NTSC Sync Generator	141
SPG2A	TV Sync Generator	142
SPG22	TV Sync Generator	142
S-1	Sampling Head	283
S-2	Sampling Head	283
S-3A	Sampling Head	284
S-4	Sampling Head	284
S-5	Sampling Head	284
S-6	Sampling Head	285
S-51	Trigger Countdown Head	285
S-52	Pulse Generator Head	285
S-53	Trigger Recognizer Head	286
S-54	Pulse Generator Head	286
TDC	TV Down Converter	153
TDC-1	TV Down Converter	153
TDC-2	TV Down Converter	153
TekTouch	CRT Screen	37
TG 501	Time Mark Generator	467
TMA802	Media Analyzer	161
TM 5003	Three-Wide Mainframe	470
TM 5006	Six-Wide Mainframe	470
TM 501	One-Wide Mainframe	471
TM 502A	Two-Wide Mainframe	471
TM 503A	Three-Wide Mainframe	471
TM 504	Four-Wide Mainframe	471
TM 506, RTM 506	Six-Wide Mainframe	471
TM 515	Five-Wide Mainframe	471
TR 502	Tracking Generator	201
TR 503	Tracking Generator	201
TSA8140	Test System Adapter	423
TSD42	Digital Interface	424
TSG11	TV Test Signal Generator	142
TSG12	TV Test Signal Generator	142
TSG13	TV Test Signal Generator	142
TSG15	TV Test Signal Generator	142
TSG16	TV Test Signal Generator	142
TSG170A	TV Test Signal Generator	141
TSG2	TV Test Signal Generator	142
TSG21	TV Test Signal Generator	142
TSG23	TV Test Signal Generator	142
TSG25	TV Test Signal Generator	142
TSG3	TV Test Signal Generator	142
TSG26	TV Test Signal Generator	140
TSG-271	PAL TV Generator	140
TSG300	Component TV Generator	145
TSG5	TV Test Signal Generator	142
TSG6	TV Test Signal Generator	142
TSG7	TV Test Signal Generator	142
TSI 8150	Test System Interface	421
TSP1	TV Signal Processor	142
TSP11	TV Signal Processor	142
TSP21	TV Signal Processor	142
TSS40	Scanner Control Assembly	424
TSS41	Low Level Scanner Card	425
TSS42	General Purpose Scanner Card	425
TSS43	Power Switch Card	426
TSS44	Coax Scanner Module	427
TSS45	RF Scanner Module	427
TSS46	Microwave Scanner Module	427
TSS48	Matrix Switch Card	426
TSX 8140	Expansion Chasis	422
VM700	Video Measurement Set	139
V-Systems	Emulation Support	97
WFM-300	Component Television Waveform Monitor	145
XY1	Output Module	155
11A32	Two Channel Amplifier	240
11A33	Differential Comparator	241
11A34	Four Channel Amplifier	240
11A52	Two Channel Amplifier	239
11A71	Single Channel Amplifier	238
110-RC	Remote Control Unit	143
110-S	Synchronizer	143
1101A	Probe Power Supply	520
1105	Battery Power Supply	332
1106	Battery Pack	332
1107	DC Inverter	333
11301	400 MHz Programmable Analog Oscilloscope	226
11302	500 MHz Programmable Analog Oscilloscope	226
11401	500 MHz Programmable Digitizing Oscilloscope	233
11402	1 GHz Programmable Digitizing Oscilloscope	233
118-AS	Audio Synchronizer	143
118F01	Audio Channel Kit	143
118F02	Video Interface Kit	143
118-RC	Remote Control Unit	143
12R01	Performance Analysis Module	118
1220	Logic Analyzer	122
1225	Logic Analyzer	122
1205	Logic Analyzer	124
1240	Logic Analyzer Mainframe	118
1241	Color Logic Analyzer Mainframe	118
134	Current Probe Amplifier	524
1360P	Programmable Switch Controller	433
1360S	Switch Matrix	433
1405	TV Sideband Adapter	201
1410R	NTSC Mainframe	142
1411R	PAL Mainframe	142
1412R	PAL-M Mainframe	142
1430	TV Noise Measurement Set	144
1434	Video Noise Generator	144
1440	Automatic Video Corrector	144
1450-1	TV Demodulator Mainframe	153
1450-2	TV Demodulator Mainframe	153
1450-3	TV Demodulator Mainframe	153
R148	PAL TV Test Signal Generator	144

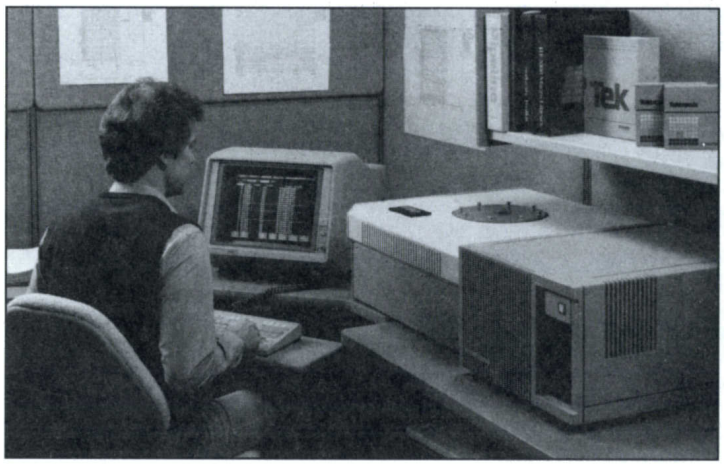
Type	Instrument Description	Page
R148-M	PAL-M Test Signal Generator	144
1480C	TV Waveform Monitor	150
1480R	TV Waveform Monitor	150
1481C	TV Waveform Monitor	150
1481R	TV Waveform Monitor	150
1482R	TV Waveform Monitor	150
1485C	TV Waveform Monitor	150
1485R	TV Waveform Monitor	150
1502B, 1503B	TDR Cable Testers	157
1705	Spectrum Monitor	146
1710B	NTSC Waveform Monitor	146
1711B	PAL Waveform Monitor	146
1720	NTSC Vectorscope	147
1721	PAL Vectorscope	148
1730	NTSC Waveform Monitor	147
1731	PAL Waveform Monitor	148
1735	PAL/NTSC	148
1740	Option 01 NTSC Waveform/ Vector Monitor	149
1741	Option 01 PAL Waveform/ Vector Monitor	149
1742	Option 01 PAL-M Waveform/ Vector Monitor	149
1750	NTSC Waveform/Vector Monitor	149
1751	PAL Waveform/Vector Monitor	149
177	Standard Test Fixture	414, 416
178	Linear IC Test Fixture	416
1910	Digital Generator	142
206, 206D	SCOPE-MOBILE® Carts	503
212	500 kHz Dual Trace Portable Oscilloscope	345
213	1 MHz Portable Oscilloscope/DMM	343
214	500 kHz Dual Trace Portable Storage Oscilloscope	351
221	5 MHz Portable Oscilloscope	342
2220	60 MHz Single Time Base Portable Digital Storage Oscilloscope	364
2221	60 MHz Digital Storage Oscilloscope	364
2225	50 MHz Oscilloscope	329
2230	100 MHz Dual Time Base Portable Digital Storage Oscilloscope	364
2235	100 MHz Dual Trace Portable Oscilloscope	322
2235L	100 MHz Dual Trace Portable Oscilloscope	322
2235 Opt 01	100 MHz Dual Trace Portable Oscilloscope	322
2236	100 MHz Dual Trace Portable Oscilloscope	320
2245	100 MHz Oscilloscope	326
2246	100 MHz w/Voltmeter/Δ Time/SmartCursor™ Oscilloscope	326
2246 Opt 1Y	100 MHz Four Channel Portable Oscilloscope	325
2335	100 MHz Dual Trace Portable Oscilloscope	316
2336	100 MHz Dual Trace Portable Oscilloscope	316
2336YA	100 MHz Dual Trace Portable Oscilloscope	316
2337	100 MHz Dual Trace Oscilloscope	316
2430A	150 MHz Dual Trace Portable Digital Storage Oscilloscope	358
2430M	Digital Storage Oscilloscope with MATE/CIIL	358
2445A	150 MHz Four Channel Portable Oscilloscope	303
2455A	250 MHz Four Channel Portable Oscilloscope	303
2465A	350 MHz Four Channel Portable Oscilloscope	303
2465A CT	350 MHz Four Channel Portable Oscilloscope	303
2465A DM	350 MHz Four Channel Portable Oscilloscope	303
2465A DV	350 MHz Four Channel Portable Oscilloscope	303
2467	350 MHz Four Channel Portable Oscilloscope	305
2710	Portable Spectrum Analyzer	196
2753P	Programmable Spectrum Analyzer	168
2754	Spectrum Analyzer	192
2754P	Programmable Spectrum Analyzer	176
2755	Spectrum Analyzer	174
2755P	Programmable Spectrum Analyzer	174
2756P	Programmable Specturm Analyzer	171
305	5 MHz Dual Trace Portable Oscilloscope/DMM	341
314	10 MHz Dual Trace Portable Storage Oscilloscope	350
318A	Logic Analyzer	126
336	50 MHz Dual Trace Portable Digital Storage Oscilloscope	368
338	Logic Analyzer	126
370	Programmable Curve Tracer	407
371	Programmable Curve Tracer	407
4041	System Controller	394
4041DDU	Disk Drive Unit	396
4205	Color Graphics Terminal	54
4207	Color Graphics Terminal	55
4208	Color Graphics Terminal	55
4209	Intelligent Color Graphics Terminal	55
4224	2D Graphics Terminal	64
4225	2D Graphics Terminal	64
4235	3D Graphics Terminal	61
4236	3D Graphics Terminal	61
4237	3D Graphics Terminal	61
4301	Applications Unit	65
4315	Graphics Workstation	68
4316	Grayscale Graphics Workstation	68
4317	Color Graphics Workstation	68
4324	2D Graphics Workstation	64
4325	2D Graphics Workstation	64
4335	3D Graphics Workstations	61
4336	3D Graphics Workstations	61
4337	3D Graphics Workstations	61
4510A	Rasterizer	75
4521	Color Video Processors	75
4522	Color Video Processors	75
466	100 MHz Portable Storage Oscilloscope	347
466DM44	100 MHz Portable Storage Oscilloscope	349
4690SC	Color Graphics Screen Copier Systems	75
4692	Color Graphics Copier	74
4692S	Color Output System	76
4693D	Color Image Printer	74
4693DS	Color Output System	76
4696	Color Ink-Jet Printer	74
4696S	Color Output System	76
492A	Spectrum Analyzer	187
492AP	Programmable GPIB Spectrum Analyzer	187
494A	Spectrum Analyzer	180
494AP	Programmable Spectrum Analyzer	180
494P	Programmable/Spectrum Analyzer	190
495	Spectrum Analyzer	184
495P	Programmable Spectrum Analyzer	184
496	Spectrum Analyzer	190
496P	Programmable Spectrum Analyzer	190
4957	Graphics Tablet	77
4958	Graphics Tablet	77
4991S1	Graphic Input Workstation	77
5A14N	1 MHz Four Trace Amplifier	296
5A15N	2 MHz Amplifier	296
5A18N	2 MHz Dual Trace Amplifier	296
5A19N	Differential Amplifier	297
5A21N	Differential Amplifier/ Current Probe Input	297
5A22N	Differential Amplifier	298
5A26	Dual Differential Amplifier	298
5A38	Dual Trace Amplifier	291
5A48	Dual Trace Amplifier	292
5B10N	Time Base/Amplifier	299
5B12N	Dual Delayed Sweep Time Base	299
5B25N	Digitizer Time Base	389
5B40	Time Base	292
5B42	Delaying Time Base	292
5CT1N	Curve Tracer Plug-in	299
5D10	Waveform Digitizer	295
50M10	Programmable A/D Converter	429
50M20	Programmable D/A Converter	429
50M30	Programmable Digital Input/Output Card	429
50M40	Programmable Relay Scanner Card	430
50M41	Programmable Low-Level Scanner	430
50M50	Programmable Memory Card	431
50M70	Programmable Development Card	432
5110, R5110A	2 MHz Single-Beam Oscilloscopes	293
5111A, R5111A	2 MHz Single-Beam Storage Oscilloscopes	293
5113, R5113	2 MHz Dual-Beam Storage Oscilloscopes	293
R520A	TV Vectorscope	150
R521A	TV Vectorscope	150

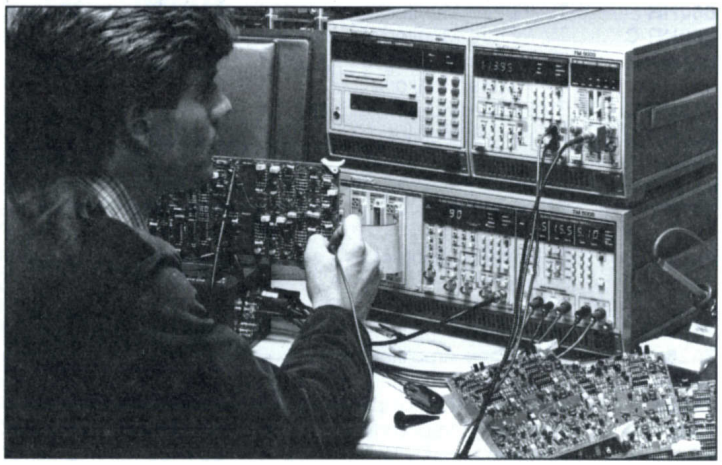
Color identifies *NEW* products

Type	Instrument Description	Page
R522A	TV Vectorscope	150
5223, R5223	10 MHz Digital Storage Oscilloscopes	387
5440, R5440	50 MHz Single-Beam Oscilloscopes	290
5441 R5441	50 MHz Variable Persistence Storage Oscilloscopes	290
576	Curve Tracer	412
577/D1	Storage Curve Tracer Mainframe	414
577/D2	Curve Tracer Mainframe	414
606B	General Purpose Waveform Monitor	40
608	High Brightness Display Monitor	40
620	General Purpose Waveform Monitor	40
634, 634LC	High Resolution Video Monitors	41
650HR	TV Picture Monitor	154
650HR-C	TV Picture Monitor	154
651HR	TV Picture Monitor	154
652HR-1	TV Picture Monitor	154
655HR-C	TV Picture Monitor	154
656HR-1	TV Picture Monitor	154
7A13	Differential Comparator Amplifier	268
7A16P	Programmable Amplifier	381
7A18A	Dual Trace Amplifier	266
7A19	Single Trace Amplifier	264
7A22	Differential Amplifier	269
7A24	Dual Trace Amplifier	265
7A26	Dual Trace Amplifier	265
7A29	Dual Trace Amplifier	264
7A29P	Programmable Amplifier	383
7A42	Logic Triggered Vertical Amplifier	266
7B10	Time Base	273
7B15	ΔDelaying Time Base	273
7B50A	Time Base	274
7B53A	Dual Time Base	274
7B80	Time Base	270
7B85	Δ Delaying Time Base	270
7B90P	Programmable Time Base	383
7B92A	Dual Time Base	272
7CT1N	Curve Tracer Plug-in	419
7D15	Universal Counter/Timer	276
7D20	Programmable Digitizer	370
7F10	Optical-Electrical Converter	267
7L12	Spectrum Analyzer	200
7L14	Spectrum Analyzer	200
7L5	Spectrum Analyzer	198
7M11	Dual 50 Ω Delay Line	283
7S11	Sampling Unit	282
7S12	TDR/Sampler	281
7S14	Dual Trace Delayed Sweep Sampler	280
7T11A	Sampling Sweep Unit	282
7104, R7103	1 GHz Real Time Oscilloscopes	249
7250	Transient Digitizer	356
751	Aural Modulation Monitor/Decoder	151
760	Stereo Audio Monitor	152
7603, R7603	100 MHz Oscilloscopes	254
7612D	200 MHz Programmable Waveform Digitizer	379
7623A R7623A	Multimode Storage Oscilloscopes	261
7633, R7633	Multimode Storage Oscilloscopes	261
7844, R7844	400 MHz Dual-Beam Oscilloscopes	256
7854	400 MHz Waveform Processing Oscilloscope	372
7904A, R7903	500 MHz Oscilloscope	252
7912HB	Digitizer	382
7934	500 MHz Storage Oscilloscope	259
830L01	Two Bank Library Pack	160
830L02	Four Bank Library Pack	160
830L03	Eight Bank Library Pack	160
830L30	IBM Library Pack	160
830M07	Memory Pack	160
830M08	Memory Pack	160
830M09	Memory Pack	160
830RDA	ROM Pack Development Aid	160
830R01	General Purpose ROM Pack	160
830RO2B	Bisynchronous ROM Pack	160
830R03	Link Test ROM Pack	160
830RO3B	Link Test ROM Pack	160
830R07	PARS/IPARS ROM Pack	160
830R10	SDLC/SNA ROM Pack	160
830R10B	SNA ROM Pack	160
830R13	SDLC/SNA ROM Pack	160
830R31	Multipurpose ROM Pack	160
834	Programmable Data Comm Tester	159
834R02A	Bisynchronous ROM Pack	160
834R04	HDLC/X-25 ROM Pack	160
834R05	Extended Instruction Set ROM Pack	160
834R06	Bisynchronous ROM Pack	160
834R11	Extended Monitor ROM Pack	160
835	Programmable Data Comm Testers	159
835BS	Bisynchronous/SDLC/SNA Package	160
835SL	Selection Package	160
835PR	PARS/IPARS Package	160
836	Programmable Data Comm Testers	159
836DV	Development Package	160
836CL	Current Loop Package	160
836L18	TV Production Library Pack	160
836TV	TV Production Protocol Analyzer	160
8540A	Microcomputer Integration Unit	97
91AE04A	Data Acquisition Module	115
91AE24	Data Acquisition Module	115
91A04A	Data Acquisition Module	115
91A08	Data Acquisition Module	115
91A24	Data Acquisition Module	115
91A32	Data Acquisition Module	115
91HS8	Data Acquisition Module	115
91HSE8	Data Acquisition Module	115
91P16	Pattern Generator Module	115
91P32	Pattern Generator Module	115
91S16	Pattern Generator Module	115
91S32	Pattern Generator Module	115
92A16, 92A16E	Data Acquisition Module	106
92A60	Data Acquisition Module	160
92A90	Data Acquisition Module	160
92HS8, 92HS8E	Data Acquisition Module	160
92S16	Pattern Generator Module	160
92S32	Pattern Generator Module	160

Tektronix Means. . . Measurement Capability, GPIB Compatibility







Tektronix' Systems Experience

Long before publication of the IEEE Standard 488-1975, Tektronix had entered the test and measurement systems business. The measurement speed and capabilities of the Tektronix automated oscilloscope and Tektronix semiconductor test systems quickly highlighted the benefits to be gained from measurement automation. Just as quickly came the realization that a system interfacing standard was needed. But what standard?

The possibilities of the proposed IEEE Standard 488 were recognized. When the IEEE Standard 488 became reality, General Purpose Interface Bus compatibility was already an integral part of Tektronix product planning and engineering. The result is that Tektronix is now a recognized major supplier of a full line of GPIB system components—a supplier that puts more than a decade of systems planning, design, and implementation experience into each product.

In 1978 the standard was further refined (IEEE Standard 488-1978) to define an interfacing system that has become a widely accepted industry standard. The major areas it specifies are:

1. Mechanical—the interface connector and cable. See Table 1.
2. Electrical—the logic signal levels and how the signals are sent and received.
3. Functional—the tasks an instrument's interface may perform (such as sending data, receiving data, triggering the instrument, etc.) and the protocols to be used. See Table 2.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical, and functional standard. These GPIB compatible instruments and instrument controllers make it possible to achieve the benefits of automated test systems without paying the previous price of custom system design. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or a star configuration.

TABLE 1. SUMMARY OF GPIB HARDWARE CHARACTERISTICS

- Cable lengths up to but not exceeding 20 meters (approximately 66 feet) with a device load required for every 2 meters of cable.
- Up to 15 devices (1 controller and 14 instruments) connected in linear or star configurations.
- Voltages generally TTL-compatible.
- GPIB signal and data lines asserted (or true) when pulled low ($\leq \pm 0.8$ V) and released (or false) when high ($\geq \pm 2.0$ V).
- Maximum data rate of up to 250K bytes/second over a distance of 20 meters, with 2 meters per device, or faster with some special restrictions (refer to IEEE Standard 488-1978 for details).

TABLE 2. INTERFACE FUNCTIONS DEFINED BY IEEE STANDARD 488-1978

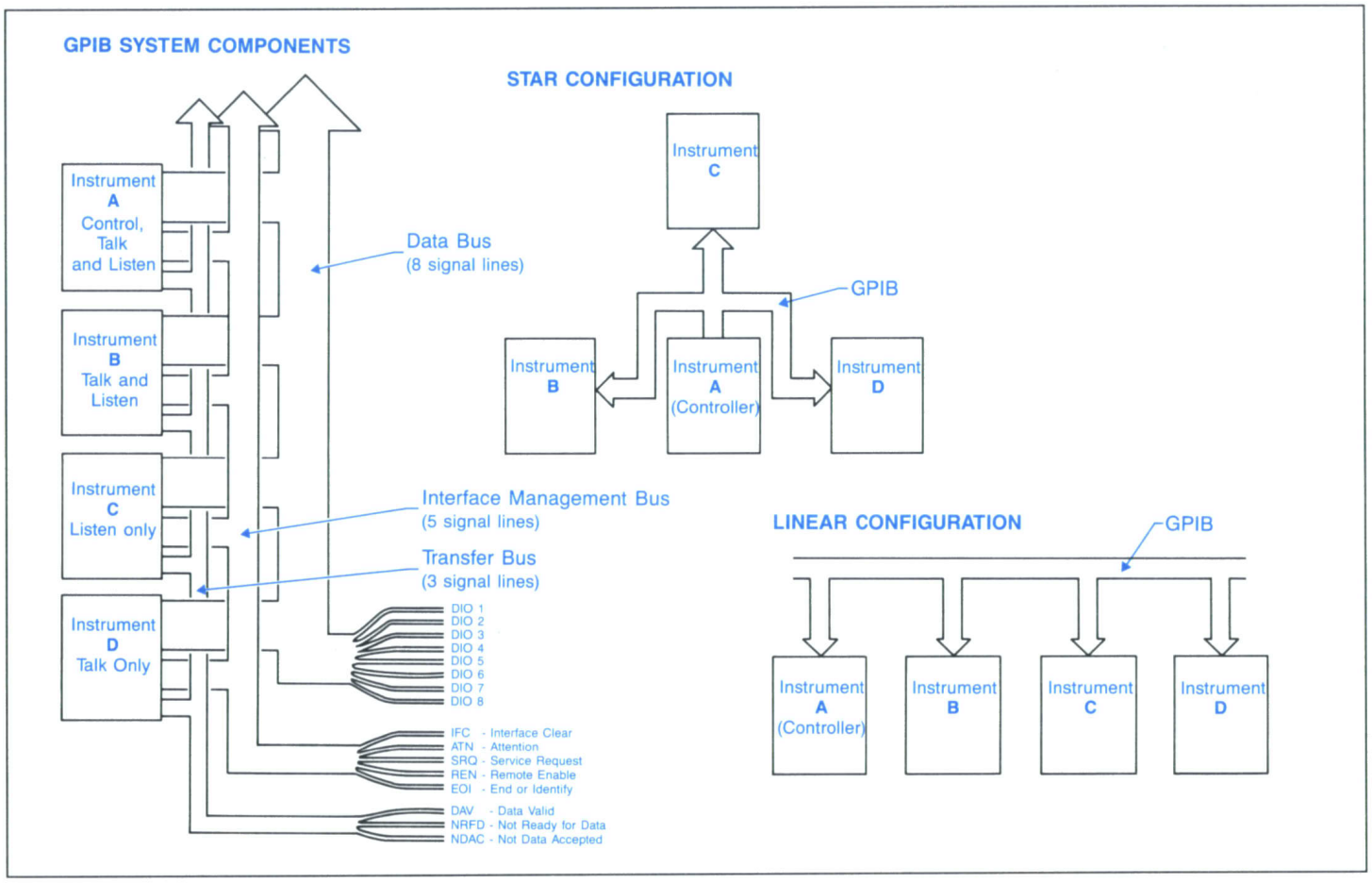
Function	Description
Source Handshake (SH)	Synchronizes message transmission
Acceptor Handshake (AH)	Synchronizes message reception
Talker (T)	Allows instrument to send data
Listener (L)	Allows instrument to receive data
Service Request (SR)	Requests service from controller
Remote-Local (RL)	Allows instrument to select between GPIB interface & front-panel programming
Parallel Poll (PP)	Allows up to eight instruments to simultaneously return a status bit to the controller
Device Clear (DC)	Puts instrument in known state
Device Trigger (DT)	Starts some basic operation of the instrument
Controller (C)	Sends device addresses and other interface messages

An automated test and measurement system usually consists of the following components:

- Multiple instruments: either *stimulus* instruments, such as function generators, pulse generators, and power supplies; or measurement instruments, such as counters, waveform digitizers, and multimeters.
- Controller with software: tells the instruments what to do, then collects and processes the results. The system controller is generally a small computer. The software or firmware operating system must have a powerful, flexible I/O structure to handle GPIB bus traffic. It must also have processing power for waveform manipulation and graphics power for display.
- Computer peripherals: devices such as tape drives, printers, and plotters that store or display results of tests.
- A keyboard: enables the user to send commands or information to the system.
- A display: allows the user to review intermediate results and to monitor system operation.

For smaller systems, one or more of the last three components are often incorporated in the system controller. Larger, more powerful systems, however, may be minicomputer-based, augmented by one or more high-speed mass storage devices, and a graphic display terminal, and run under specialized instrument control and signal processing software such as TEK SPS BASIC.

All of these components can be easily interconnected if the GPIB interface has been built in, and appropriate functions made programmable. Before GPIB, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. GPIB removes this requirement. Users can directly link up to 14 instruments with the controller via the bus, and set up the systems in linear or star configurations. Some controllers can drive more than one GPIB port. The Tektronix 4041, which has an option for a second port, allows control of up to 28 instruments. If you need more, TEK SPS BASIC operated with a properly optioned DEC PDP-11 minicomputer can drive up to four GPIB ports, providing a total system potential of 56 instruments.



All these devices (the controller, measurement instruments, and peripherals) comprise the hardware. The system cannot operate, however, unless it is driven by software.

There are two levels of software necessary: the operating-system software and user-written application programs. The operating-system software provides a set of commands and functions that the user combines into a program that delineates the measurement and processing task to be performed. The software, guided by the user program, works through the controller to tell the instruments what signals to generate, and what measurements to make, and tells the controller what to do with the results.

The software and the program in the controller make the system do what the user wants. The GPIB interface allows users to plug system components together, but without software the system can do nothing.

In programmable instrument systems, the "language" of the software or program has several meanings:

- The controller has its own language, such as BASIC or C, and users must express their intentions in this language.
- Within the context of the controller's language, the instrument's commands (or "Language") have to be sent over the GPIB.
- The actual control of the GPIB interface is transparent to the user with Tektronix instrument controllers and software.

To make the system operate, the user has to know:

- What tasks the system is to perform—the system can do nothing by itself.

To make these tasks easier for you, Tektronix has taken several steps beyond simple IEEE Standard 488-1978 compatibility. Consistency has been designed into each system component for the greatest degree of compatibility. Intelligence has been designed in to relieve you from interfacing details. Firmware and software have been designed and written to provide the maximum in programming ease and measurement capability.

Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE Standard 488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users usually won't need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

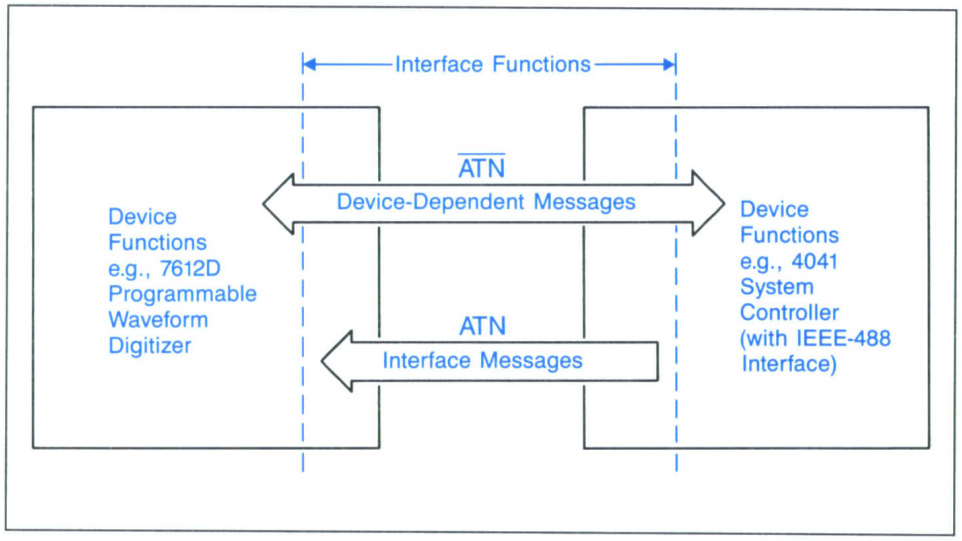
A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit. Since the IEEE Standard 488-1978 allows several optional message terminators, Tektronix instruments go an extra step by providing a switch for selecting optional terminators. These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

The result is a line of products that are not only GPIB compatible, but are also capable GPIB instruments. They have the features that make them useful and the compatibility that makes them work together.

Tektronix *Standard Codes and Formats* Means Programming Ease

IEEE Standard 488-1978 specifies the hardware interface and its basic functional protocol. It also specifies a set of codes called interface messages that control interface functions. However, the IEEE Standard 488-1978 does not specify the syntax or coding of device-dependent messages—the messages that control the programmable features of the instrument.

Since the device-dependent messages are not specified, instruments that conform to the IEEE Standard 488-1978 may use inconvenient or even incompatible message formats. It's much like a telephone system—the hardware link is well defined, but unless both parties



speak the same language, communication is impossible. That's why Tektronix developed a codes and formats standard that specifies the syntax and coding of device-dependent messages, while retaining full IEEE Standard 488-1978 compatibility. The Tektronix *Standard Codes and Formats* specifies message coding to:

- Be simple and unambiguous.
- Use commands that are common among similar devices.
- Use simple, easy-to-remember mnemonics.

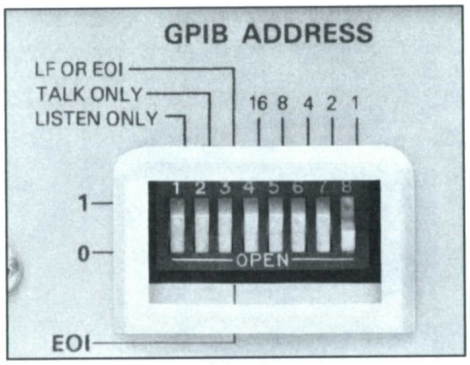
The benefits of the Tektronix *Standard Codes and Formats*, a major feature of the Tektronix GPIB communications protocol, are numerous. Because of their natural English-like structure, instrument control commands and messages are easy to use. The result is a GPIB implementation that is specifically designed to overcome the programming rigidity and cumbersome procedures of other GPIB systems.

ASCII Data Standard

Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This procedure eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set the center frequency of the 492AP Spectrum Analyzer to 1.75 MHz, the command is simply written FREQ 1.75 MHz—no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human-readable form.

Flexible Formats

Many minor format items that are aggravations in other systems are also taken care of by Tektronix *Standard Codes and Formats*. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper- and lower-case letters. Since truncated numbers can drastically affect measurements, Tektronix GPIB instruments round off rather than truncate: e.g., a value of 2.49 becomes 2.5 rather than 2.4. In short, the built-in intelligence is used to make intelligent decisions. That makes your programming job much less rigid and substantially easier.



Each GPIB instrument or peripheral, called a device, must be assigned a different system address; this can be done simply by setting switches, usually located on the back panel of the device.

Common Messages

To make things even easier, Tektronix *Standard Codes and Formats* also specifies messages that are to be common to all Tektronix programmable instruments. For example, you can program your system to learn the current settings of any Tektronix GPIB instrument by sending the instrument the SET? message. Any GPIB-compatible instrument from Tektronix—whether it is a waveform digitizer, a programmable power supply, or a function generator—interprets SET? the same way. The instrument firmware gathers the instrument's settings together and assembles them into a human-readable message to be sent over the bus to the controlling software. If you know how to operate a function generator, then you already know how to read a settings message from a Tektronix GPIB-compatible function generator.

BASIC Languages

Because users are increasingly interacting with GPIB systems at the controller keyboard rather than at instrument panels, GPIB systems must be as friendly as possible. Therefore, controller languages should be simple, logical, and easy to interpret and implement. That's why BASIC is the primary language used by Tektronix instrument controllers and is the preferred language of Tektronix *Standard Codes and Formats*.

BASIC is an established language with wide use and familiarity. It is also an English-like language that is easy to learn and understand. So, combined with the English-like messages used with Tektronix GPIB instruments, it becomes a consistent and familiar means of communicating with your system. Your program listings are easy to read and follow, with very little interpretation required. (For more details on Tektronix *Standard Codes and Formats*, ask your Tektronix Sales Engineer or representative.)

Controllers and Software to Match Your Needs

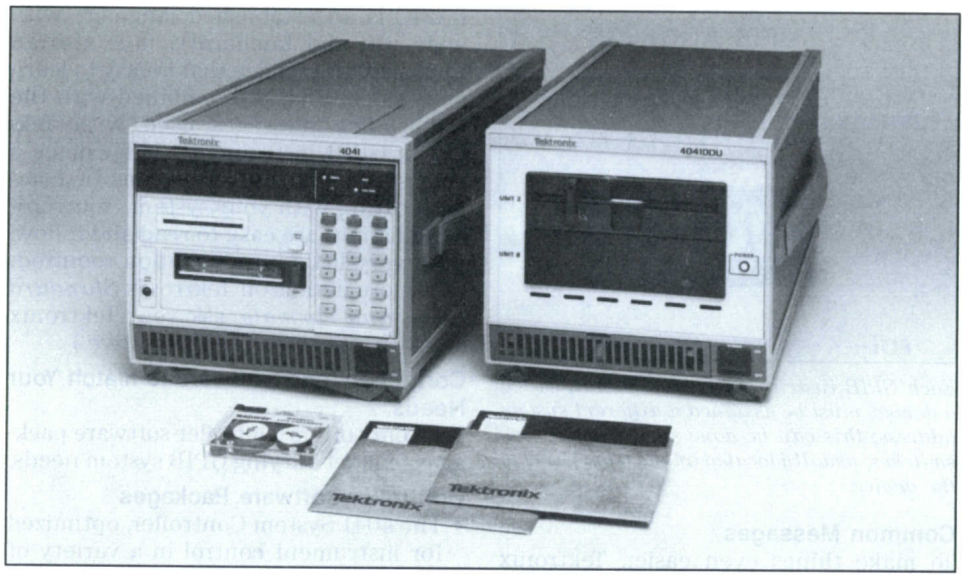
Tektronix offers controller-software packages to meet varying GPIB system needs.

Controller/Software Packages

- The 4041 System Controller, optimized for instrument control in a variety of situations, including test and measurement and spectrum analysis.
- TEK SPS BASIC software with the DEC PDP-11 Series and DEC Micro PDP-11 mini-computers, optimized for systems with full waveform acquisition, processing, and graphics.

Software Packages

- GURU II software, an interface package for the IBM PC (or IBM-compatible PC), using National's GPIB card. This package contains a TEST PROGRAM GENERATOR, programming examples, and an excellent manual to help the novice user get started or the familiar user be more productive.
- The TekMAP (Tektronix Measurement Applications Programs) library of software products supports the Tektronix 7000 Series GPIB-programmable digitizers and extends the digitizers by integrating them with Tektronix controllers, IBM personal computers, or HP Series 200 technical computers.



Tektronix 4041 System Controller

4041 System Controller and 4041 DDU
The 4041 System Controller is a compact, modular controller designed for rack-mount, bench-top, or portable use. Its operating-system language is an extended BASIC designed for use by both the casual and the sophisticated programmer.

The 4041 Controller contains three microprocessors, with the CPU being the powerful 16-bit 68000. Standard memory is 512K bytes. A 20-character alphanumeric LED display, 20-column thermal printer, DC-100 magnetic tape cartridge drive, 18 function keys, GPIB port, RS-232 port, and real-time clock and calendar capability are all standard. An additional GPIB/RS-232 port pair is optional, with the second GPIB port having Direct Memory Access capability. With 14 GPIB instruments per GPIB port, the 4041 System Controller offers the capability of controlling up to 28 GPIB instruments. Other options include an 8-bit parallel TTL interface (Option 02); Small Computer System Interface (Option 03) for external disk mass storage; a second RS 232 port to support interfacing to floppy and hard disks for greater file and data storage; and a detachable program development/debug keyboard.

The 4041 DDU enhances 4041 operation by providing a 10.6M byte hard disk drive and a 320K byte flexible disk drive. The 4041 DDU works with the 4041 Option 03 SCSI Interface.

The capabilities of standard 4041 BASIC can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications, with functions running faster than equivalent BASIC routines. The program development ROMs (with keyboard, or an RS-232 terminal), give the engineer or production test programmer access to the system language. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for a friendly and interactive system. A variety of other features are also included to increase friendliness. For example, variable names may be up to eight characters long, allowing meaningful names such as RISETIME, VOLTAGE, or DELAY. As another example, subprograms and program lines can be named—e.g., 1000 SRQPOLL: or 200 RMS VOLTS—for quick and easy access.

Beyond enhancements for simplicity, 4041 BASIC also has enhancements that make it a powerful tool for sophisticated programmers. It includes capabilities for FORTRAN-like subprograms, variable passing from main program to subprograms, declaration of local and global variables, and many other features.

Yet, for all its sophistication, the 4041 is still particularly desirable for use by lower-skill operators in a production environment. Instrument control programs can be designed and written to print user prompts on the 4041 display and the programs can be assigned to any of the ten user-definable keys on the 4041 front panel. The 4041 program development ROM and keyboard can then be removed from the controller to put the 4041 into an execute-only mode with its programs protected. The lower-skill user need only follow the front panel display prompts and press the designated keys to execute programs.

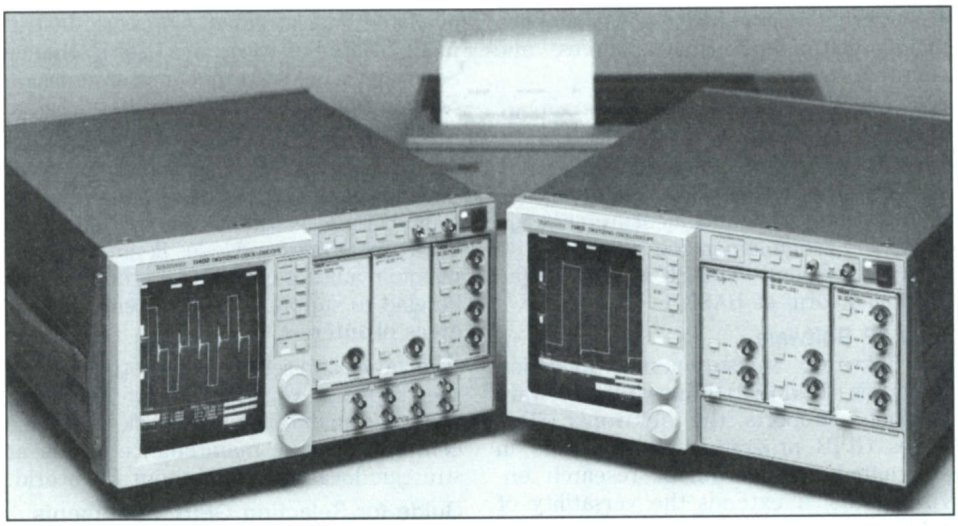
To return to the engineering or program development mode, simply plug the program development ROMs (with keyboard or an RS-232 terminal) back into the 4041. You again have access to all of the ease and power of 4041 BASIC programming. The 4041R01 Graphics ROM pack gives the 4041 the capability to generate graphic commands to interact with peripheral devices using Tektronix-compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system applications, greatly enhancing system usability.

The 4041R02 Plotting ROM Pack gives the 4041 the capability to generate graphs and to plot data. Designed as an easy-to-use tool to automatically generate scientific graphics, the plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack in order to operate. Graphs can be generated and displayed on any graphic peripheral device supported by the 4041R01. The automatic plotting commands are the heart of the 4041R02. These commands, given your data, draw axes with appropriate tic marks and plot the desired data. You need little experience to program graphics or plotting routines. All you need to do is supply the data to be graphed.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Coupled with our programmable digitizers and oscilloscopes, it will produce broader system configurations and effective solutions for signal analysis. The functions contained in the 4041R03 provide a high-level approach to deal with signal-processing applications normally solved by lengthy programs requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms semiautomatically.

The 4041R04 Utility ROM Pack adds still more general-purpose capabilities to your 4041. These features range from such convenience items as one-line descriptions of error codes to capabilities for building PROM files for programming your own EPROMS.

4041 Option 10 combines the functionality of the RO1 through RO4 ROMs on the CPU board, and also includes the UTL2 utility routines.



11400 Series Digitizing Oscilloscopes

The 11401 and 11402 are fully programmable digitizing oscilloscopes with 500 MHz and 1 GHz bandwidth respectively. They provide test engineers with a very flexible tool set. Multiple processor architecture performs waveform processing and automatic measurements with a fast, continuous update rate. Automatic measurement saves test development time and reduces errors. Measurements can be customized easily to meet unique individual requirements, e.g., width measurements can be made at any percent level. Time and amplitude measurements can be "gated" using measurement zone limiters.

Amplitude measurement functions include peak-to-peak, maximum, minimum, mid, RMS and mean. Timing measurement functions include width, rise time, fall time, propagation delay, crossing location, frequency, period, delay and a hardware time A→B function called main-to-window trigger time. Area and energy measurements are also performed automatically.

Amplifiers used in the 11400 Series are very accurate, very linear and have a predictable frequency response. They deliver your signal to the measurement system accurately ensuring measurement repeatability and integrity. Accuracy is sufficient to perform measurements generally requiring dedicated ac volt meters.

Waveform processing functions and a full set of automatic waveform measurement features are easily accessed over either the IEEE-488 or RS-232C interfaces. For example, to measure rise time, simply send the following query to the 11400: ***RISE?***. Measurement and waveform throughput are very high to help reduce testing time and cost. Fast waveform transfers are available over the GPIB with the help of a DMA device (option 4D).

The 11401 can process and measure signals from high-bandwidth 50 Ω amplifiers, high-impedance amplifiers, and differential amplifiers. 1 mV sensitivity and 500 V maximum input voltage let users capture small signals from transducers or monitor ac power lines.

Custom System Services

Three tiers of Tek Custom Services are available to ease your selection process. Custom Systems offer single-shot or repetitive measurement capability and control of up to 56 GPIB instruments per controller, fully configurable to your specifications. Included are full warranties, installation, and other product support services.

While we provide the core system package, specialized drivers, and software operating system after consultation with your software engineers and operating personnel, it is generally more cost-effective for you to provide your own applications software. Users are then better prepared to do routine modifications and updating, and you gain the local expertise you need to make the best use of your system investments.

Customized Measurement Packages

Customized Tektronix Measurement Packages are modifications to existing preconfigured systems. Each package offers powerful capability in a cost-effective benchtop size. Signal-acquisition units span bandwidths of up to 750 MHz real time and up to 14 GHz with sampling plug-ins.

Modified Products

Modified Products include the customization of selected digitizers, as well as the "system glue" (specialized internal interfaces, etc.) required to hold the system together.

These off-the-shelf custom items for your system needs include:

- Additional serial I/O drivers for your communications/printing needs. Up to 8 instrument channels and up to 4 peripheral ports may be supported.
- Special disk drivers for RL02 disk pack drives and for TEK SPS BASIC V02.
- GPIB program decoder plug-in that enhances the 7854 oscilloscope by interfacing to programmable vertical and time base settings with selected plug-ins.
- High-speed data-output modification for the 390AD digitizer.
- A high-bandwidth modification (750 MHz) of the 7912AD Digitizer.
- Auto-calibration MUX controller and stimulus generator.
- Others per your request.

TEK SPS BASIC Software with DEC PDP-11 Minicomputers

When equipped with Tektronix-supplied GPIB interfaces, DEC PDP-11 Series minicomputers can be operated with TEK SPS BASIC software to provide the most powerful big-system instrument control and signal processing. A wide variety of peripherals can be handled, including plotters, line printers, graphic terminals, magnetic tapes, and single or multiple disk storage systems. In addition, with the proper options, up to four GPIB interface ports can be supported to provide control of and data collection from up to 56 GPIB instruments.

Two versions of TEK SPS BASIC are available, the standard version and the extended memory version. The extended-memory version permits processing of very large arrays in computers with memory management.

Other than memory differences, both versions of TEK SPS BASIC software have the same major features, including a modular architecture consisting of a resident monitor and an expandable library of over 100 nonresident commands. This unique design lets you configure a software system to meet your specific needs yet leaves the system open for adding new commands and processing modules.

Measurement data can be stored and accessed in a variety of ways. Information can be read or written in either ASCII or binary. Named files can be accessed on hard or flexible disks, magnetic tape, or cassettes. Information can be read from files either sequentially or randomly. TEK SPS BASIC commands give you complete file-management capability.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

There's also data-logging capability for automated waveform capture. Because the software's precision is better than 7 digits, much higher resolution is possible than in

conventional oscilloscope measurements. In addition, there are special data structures to retain both numeric and literal information (scale factors and units) associated with a given waveform. This waveform data structure, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Beyond extending the standard mathematical operations and functions to include waveform-processing, TEK SPS BASIC also provides special waveform processing functions. Waveforms can be integrated, differentiated, convolved, correlated, and Fast Fourier transformed—all with single commands. Polar conversions can also be performed with a single command to present results such as magnitude and phase.

With its large array-size capabilities (limited only by memory in most cases), advanced signal processing, and program and instrument tasking capabilities (including error control for independent operation), TEK SPS BASIC offers all of the flexibility and power necessary to control anything from the simplest to the most sophisticated test and measurement system.

SPD Software

Signal Processing and Display (SPD) Software supports 196 processing, analysis, and data-to-display functions using Tek digitizers in conjunction with an IBM PC, PC/XT, or PC/AT. Designed for scientific and engineering applications, this package includes complete mathematical functions plus waveform data, I/O utilities, analysis, processing, and graphic display functions. Access is via disk or GPIB port using popular waveform digitizers.

GURU II Software

GURU II is a simple but powerful package that provides control of GPIB (IEEE Standard 488) electronic instruments from an IBM PC (or compatible). It offers the menu-driven Test Procedure Generator to speed applications programming.

GURU II's Test Procedure Generator (TPG.BAS), written in BASIC, is a self-explanatory menu-driven program. It is the right tool for instrument system users who want fast results or who don't want to learn to program their system in BASIC. It allows users to generate a program that runs a specific test sequence—without writing a single line of code. Users need to know only the details of the test to be performed and the equipment used.

The TPG is most suited to nondigitizer applications where testing of devices is required using programmable power supplies, digital voltmeters, signal sources, and counters.

For users who want to write their own application programs, GURU II provides SUBS.BAS, a set of canned subroutines. These subroutines perform functions common to many test and measurement applications, complementing the IBM PC compatible Microsoft BASICA language (an advanced form of BASIC).

TekMAP Software

The Tektronix Measurement Application Programs (TekMAP) library of software products supports the Tektronix 7000 Series GPIB programmable digitizers in automated engineering or research environments. It extends the versatility of Tektronix digitizers by integrating them with Tektronix controllers, IBM personal computers, or HP Series 200 technical computers.

Basic communication utilities, accessible through friendly menu-driven user interfaces, are available through Communication and Control Utility Software.

Extended measurement capabilities (such as automated pulse parameter analysis, Fast Fourier transformation, and propagation delay measurements) are provided by the Time and Amplitude Measurement Software products.

Tektronix Support for Your GPIB System

With GPIB products and signal-processing systems from Tektronix, you're not left on your own after the product is purchased. Tektronix offers complete support and training for the operation and maintenance of its GPIB products and systems.

Every product is shipped with a complete and comprehensive operating manual. In addition, a variety of training services are available. Training classes are available both at our home office and at selected sites around the world.

As part of the long-term support for GPIB products and systems, Tektronix offers a variety of application literature and support.

HANDSHAKE is an applications newsletter published quarterly by Tektronix that contains application and technical articles covering the broad spectrum of instrument control and signal processing.

The Tektronix Instrumentation Software Library provides software and application information for Tektronix programmable measurement instruments and systems. Three types of software are currently available: Measurement Software, Instrument Utility Software, and User Exchange Software. The Tektronix Instrumentation Software Library catalog provides program abstracts and ordering information.

An extensive collection of application notes and magazine article reprints is another source of information offered by Tektronix. Our Sales Offices and Sales Representatives maintain a list of current literature and will be glad to supply you with items in your areas of interest.

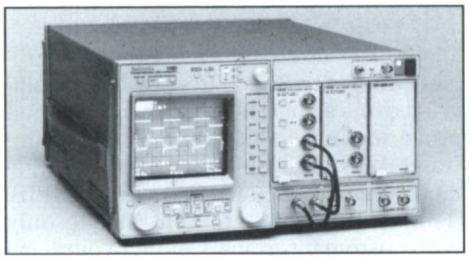
Warranties and service are another part of the support you get from Tektronix. Tektronix maintains a network of service centers for your maintenance needs at strategic locations throughout the world.

Guide for Selecting GPIB Instruments

When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitability in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your sales representative when considering instruments to be used in GPIB configurations:

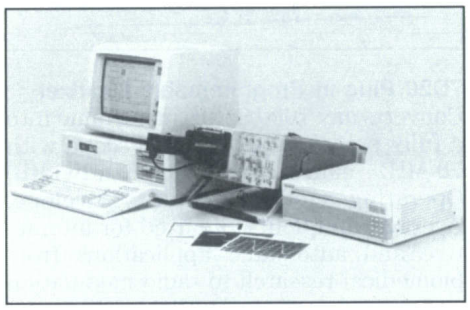
1. Is the instrument intended for interactive measurement analysis or automated measurement (i.e., are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?).
2. Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level? (e.g., AH1 is needed for any useful interaction, SH1 is required for instruments supplying measurements to the controller.)
3. Are diagnostics available to check out the instrument from the front panel or over the GPIB interface?
4. Does the instrument use standard codes and formats conventions for terminators, numeric formats, etc.?
5. Can the instrument's front-panel setting be read from the controller and saved for later automated set up?
6. Can the front panel be "locked out" via the GPIB?



ANALOG OSCILLOSCOPES

11301 and 11302

These oscilloscopes offer a new degree of measurement versatility up to 500-MHz bandwidth. Full programmability via either the GPIB or RS-232C plus a touchscreen operator interface make these plug-in scopes ideal for both automatic test systems and benchtop applications. A built-in 500-MHz counter/timer and peak detecting make measurements that normally require a digitizer. An automatic measurement sequence provides common pulse parameters at the touch of a button. Template waveforms allow comparison of complex signals with predefined limits. Cursors allow dc measurements to within 0.2%. The results of all measurements are displayed numerically on the CRT and are available over either bus.

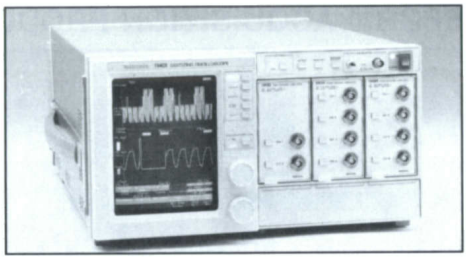


DIGITIZING CAMERA SYSTEM

DCS01 Option 1C

The DCS01 Digitizing Camera System combines CCD technology with an IBM PC, XT, AT, or compatible to acquire and digitize repetitive and transient waveforms displayed on oscilloscopes, spectrum analyzers, and other displays. Used with scopes having the microchannel plate CRT, such as the 7104, 11302, and 2467, the DCS01 can acquire repetitive and transient signals at the full bandwidth of the scope. With other scopes, the DCS01 will acquire repetitive events at the full scope bandwidth and transient events according to the photographic writing rate of the oscilloscope.

Optional software packages allow the DCS01 to communicate with the 2467 or the 11302 oscilloscopes. This link permits scale factors to be "Read" or changed via the GPIB.



DIGITIZING OSCILLOSCOPES

11401 and 11402

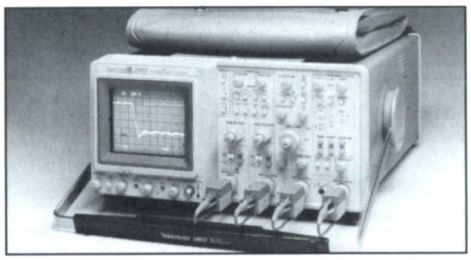
The 500-MHz 11401 and the 1 GHz 11402 oscilloscopes are equally at home in a system or on a designer's bench. Full programmability through both the GPIB and RS-232C, direct memory access option for fast waveform transfer through the GPIB, extensive waveform processing along with pulse parameter analysis, and 200-ps single-shot resolution on time A→B measurements combine to make these scopes ideal for automated environments. These scopes are easily adapted to rackmounting and can be equipped with cable feedthroughs that make it possible to connect signals to the rear of the instruments. Accurate, automatic measurements of voltage, timing, and area/energy can easily be set up and read out over either standard bus.

PORTABLE OSCILLOSCOPES

2430A and 2430M

The 2430A brings the best features of our industry standard 2400 Series into the digital world. It features 150-MHz bandwidth, dual-channel simultaneous acquisition, 5-ns maximum sweep speed, 8-bit vertical resolution. The Tek-patented feature, "Save-on-Delta", makes pass/fail decisions. The 2430A is fully programmable over the GPIB. It sends and receives waveforms, front-panel settings, custom menus, and operator prompts. Outputs include an analog plotter output. It is compatible with the P6407 Word Recognizer probe.

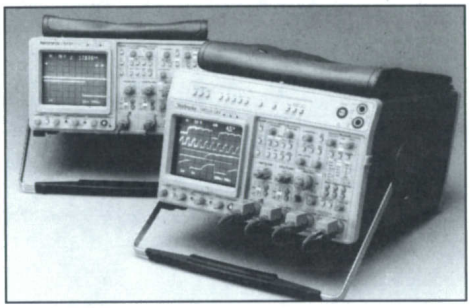
The 2430M offers all features of the 2430A, plus CIIL capability for operation in Modular Automatic Test Equipment (MATE) used in testing military avionics and weapons systems.



PORTABLE OSCILLOSCOPE

2467 Option 10

The 2467 has the fastest visual writing rate available in a portable oscilloscope due to the microchannel plate CRT, which amplifies the brightness of transient events. The 2467 Option 10 can be easily programmed to assist the scope operator to perform a complete sequence of measurements. Front-panel settings can be remotely set or changed via the GPIB. Measurement results can be both displayed on the CRT and read back over the bus. Auto set-up scales the vertical, horizontal, and trigger systems to provide a stable, automatically triggered display of the waveforms.

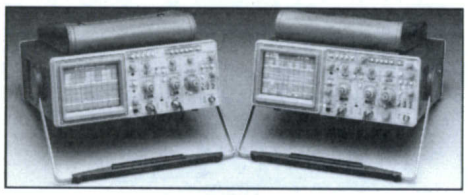


PORTABLE OSCILLOSCOPES

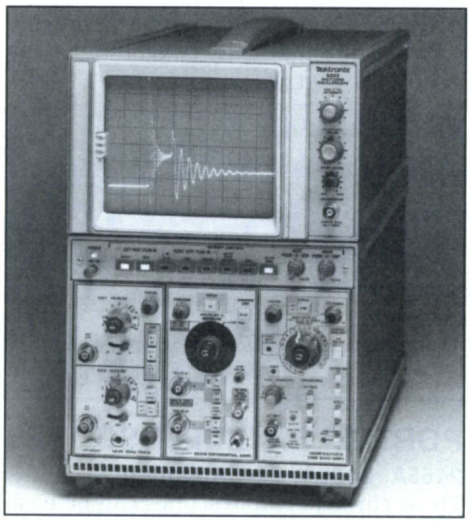
2465A, 2455A, 2445A Option 10

These three portable scopes can be easily programmed to assist the scope operator complete a sequence of measurements. Front-panel settings can be remotely set/changed with display prompting of messages, providing operator guidance. The results of voltage, time, frequency, phase, and ratio can be both displayed on the CRT and read back over the bus. In addition, Auto Set-Up scales the vert, horiz, and trig systems to provide a stable, automatically triggered display of the probed waveforms. A Save/Recall utility provides up to 20 setups for automating repetitive measurement sequences. CT versions are ideal for automatic frequency, period, pulse-width, and time-between-events measurements; the DM for automatic counter and digital tests and measurements; and the DV for high-resolution video applications.

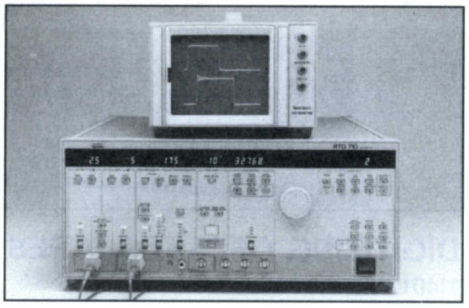
WAVEFORM ACQUISITION PRODUCTS



2200 Digital Storage Oscilloscopes
The 2200 family of portable scopes offer both analog and digital capability to 100-MHz (2230) and to 60-MHz (2221, 2220). All scopes offer "Peak Detect Mode", allowing glitch capture to 100 ns at any sweep speed. The 2230, 2220, and 2221 also feature unlimited storage time, pre/post trigger viewing, roll/scan modes, and standard X-Y plotter output. Options include RS-232-C or GPIB interface capabilities. In addition, the 2230 includes battery-backed memory with other options to allow saving up to 26 waveform sets.

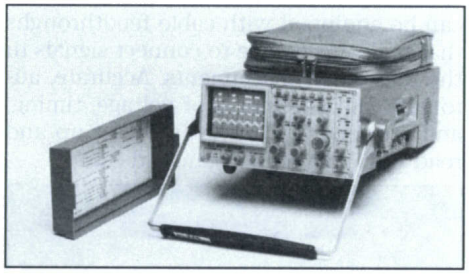


5223 Option 10 Digitizing Oscilloscope
This 10-MHz digital storage scope provides a digitized display that will never fade or bloom. Roll mode yields a continually updated display of memory contents with a strip-chart-like view of signals at slow sweep rates. Applications range from measuring mechanical displacement transducer signals to biomedical activities. Option 10 provides I/O of stored waveforms and control of 5223 storage functions (except vert and horiz expansion and position controls). Waveform output format is selectable through this interface for either Binary or ASCII. Plug-in functions not remotely controllable.

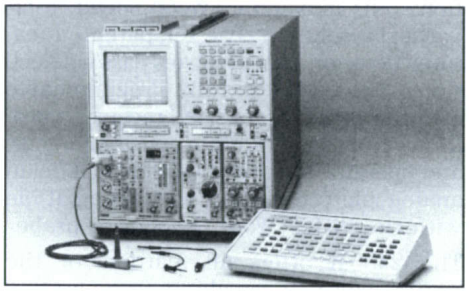


RTD 710 Programmable Digitizer
This 2-channel, 10-bit digitizer achieves excellent dynamic accuracy with a 2-stage flash-conversion process.

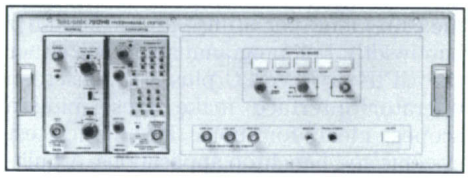
Single-channel operation can provide 200 megasamples per second. It features built-in self-calibration and self-test and is remotely controllable over the GPIB. Applications vary from ultrasonic testing to video.



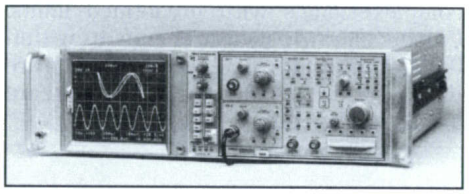
336 Digital Storage Oscilloscope
This compact scope can simultaneously display analog and digital waveforms, and can store up to 16 for recall and display. Nonstorage bandwidth is 50 MHz; storage bandwidth is 140 kHz. Vertical and horizontal scale factors, delay time position, and voltage and time readouts of cursor positions are displayed on the CRT, as is a menu of many of the features and modes. An Auto mode for both vertical volts/division and horizontal time/division allows "hands-off" operation in many applications.



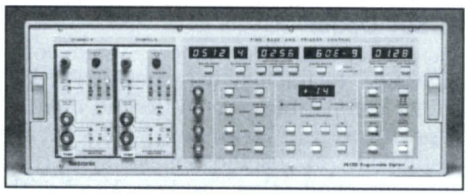
7854 Waveform Processing Oscilloscope
This two-channel, digital storage oscilloscope has 400-MHz equivalent-time bandwidth. Keystroke programming of local keyboard and remote waveform calculator allows user-designed waveform measurement routines. Signal averaging capability recovers signals buried in noise and improve measurement accuracy. All mainframe keystroke functions and operating modes remotely controlled via the GPIB. (Plug-in functions are controllable only with custom interface. Contact your local Sales Engineer.) The 7854 is supported by TekMAP 7854/IBM PC Communication software.



7912HB Programmable Digitizer
The 7912HB is designed for interactive and automated applications. It digitizes and stores single-shot or repetitive signals from millisecond to subnanosecond duration.



7D20 Plug-in Programmable Digitizer
Converts any 7000 Series mainframe into a fully programmable, digital scope with 70-MHz equivalent time bandwidth. Operating modes include: Envelope, Average, and Roll. Optimized for interactive and automated applications from biomedical research to radio modulation and is remotely controllable over the GPIB. It is shown with R7603 mainframe.



7612D Programmable Digitizer
Two independent waveform digitizers in one compact instrument, the 7612D is ideal for use with Automatic Test Equipment or anywhere highly accurate, time-domain measurements are required. Memory partitioning helps capture fast, successive, randomly occurring events. Multiple sample rate switching is available during waveform acquisition. The 7612D is remotely controllable over GPIB.

SYSTEM CONTROLLER

4041 System Controller

This powerful and expandable system controller is intended principally for execute-only environments such as production line testing. Operating parameters include Interrupt and Error Handling modes. Options and peripherals equip it for interactive flexibility in research lab applications. Programming language is BASIC with English-like commands, extensions, simple syntax, and line-by-line interpreter. A 20-column thermal printer is built in.

DESKTOP CONTROLLER-BASED PACKAGES

MP 2501

Based on the Tektronix 7854 Oscilloscope and the 4205 Color Graphics Display Terminal/4041 System Controller, this system can acquire, process, store, and display electrical signals. 4041 BASIC routines from the Utility Software permit system operation with limited programming experience. The 7854 is remotely controllable over the GPIB.

MP 2101

Based on the Tektronix 7912HB Programmable Digitizer, the MP 2101 is a high-speed, signal acquisition and transient digitizing system. The 7912HB is remotely controllable over the GPIB. It utilizes the 4041.

MP 2201

Based on the Tektronix 7612D Programmable Digitizer, the MP 2201 is a complete signal acquisition, waveform processing, storage, and display system. The 7612D is remotely controllable over the GPIB and utilizes the 4041.

MP 1101

Based on the Tektronix 7912HB Programmable Digitizer, this compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller.

MP 1201

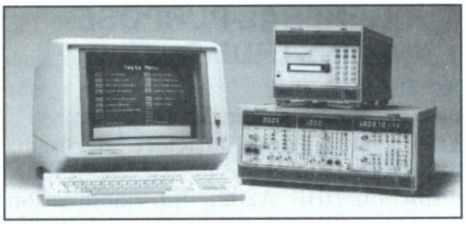
Based on the Tektronix 7612D Programmable Digitizer, this compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller.

MP 2701

Based on the Sony/Tektronix RTD710 Programmable Digitizer, the MP2701 is a complete signal acquisition, waveform processing, storage, and display system. The RTD710 is remotely controllable over the GPIB and utilizes the 4041 System Controller.

MP 1701

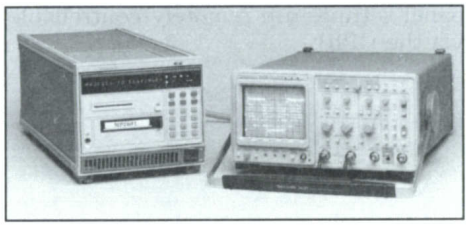
Based on the Sony/Tektronix RTD710 Programmable Digitizer, this compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB interface from any suitable controller.



AUDIO MEASUREMENTS PACKAGE

MP 2902

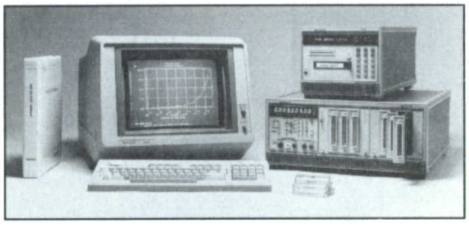
The Audio Test Program Generation software allows rapid development of an automated audio measurement system, even by nonprogrammers. Tests supported include: total harmonic distortion vs frequency, total harmonic distortion vs output level, intermodulation distortion vs level (SMPTE and CCIF), CCIF intermodulation distortion vs frequency, frequency response, signal-to noise, level (voltage and power), linearity, external stimulus, and others.



OSCILLOSCOPE MEASUREMENT PACKAGE

MP 2601

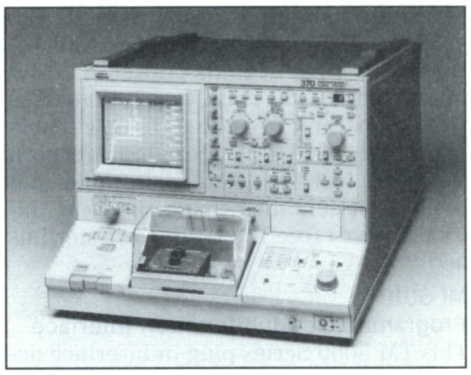
The MP 2601 couples the 4041 Controller with the 2430/2430A Digital Oscilloscope for simultaneous two-channel signal acquisition with 150-MHz bandwidth. This portable measurement package provides extensive signal acquisition capabilities with signal analysis to form a system directed at measurement solutions.



INCOMING INSPECTION TEST STATION

MP 2901

The MP 2901 addresses two of the most difficult aspects of automating an operation-software development and interfacing to the device under test. The multifunction interface (MI 5010) allows easy data acquisition and/or control of the device under test by the 4041 System Controller. The task of software development is made rapid and easy. TEK EZ-TEST leads nonprogrammers (via a set of menus) to translate manual procedures into error-free, structured BASIC code.



CURVE TRACERS

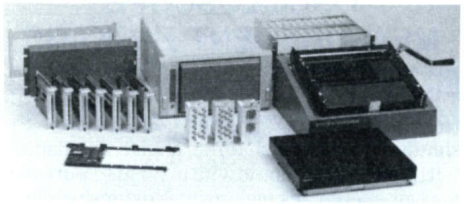
370 Programmable and 371 High Power

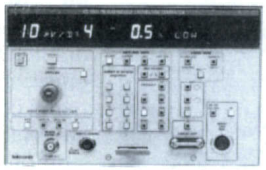
The 370/371 Curve Tracers are remotely controllable via the GPIB for automated acquisition of curve data. Characteristic curve data can be sent in either direction over the bus. Front panel controls, except for those intended for local use only (such as Intensity), can be remotely set with a controller (like the Tek 4041) or with an IBM PC or compatible.

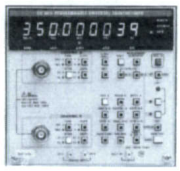
Recommended GPIB Cables

Part Number	Description
012-1015-00	0.5 meter, single shield
012-0991-01	1 meter, double shield, low EMI
012-0991-00	2 meters, double shield, low EMI
012-0991-02	4 meters, double shield, low EMI

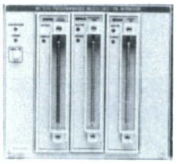
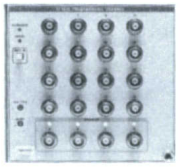
TSI Family

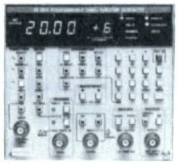


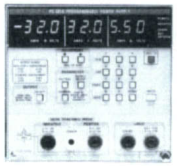




AA 5501/SG 5010 CG 5001 DC 5009 DC 5010





MI 5010 SI 5010 DM 5010 FG 5010 PS 5004 PS 5010

SIGNAL ROUTING/DUT INTERFACING

The Test System Interface (TSI) Family of off-the-shelf components can be easily configured to fit a majority of signal switching and DUT interfacing needs. The TSI can range in complexity from a mainframe and a single switching assembly to DUT interfacing and multiple card/module switching configurations for up to 720 channels. Cards and modules are available for switching signals ranging from microvolts to 400 volts, from microamps to 10 amps, and from dc to 18 GHz. Rack-mounting and GPIB operation are both standard features. The mainframe and control assemblies have built-in intelligence to free the GPIB for other bus activities.

MI 5010
Programmable Multifunction Interface

This TM 5000 Series plug-in interface accommodates 3 front-panel plug-in cards. The MX 5010 Multifunction Interface Extender provides space for three additional cards. A total of six function cards can be remotely controlled via the GPIB.

SI 5010
Programmable RF Scanner

This TM 5000 Series plug-in uses 16 RF reed relays to interconnect 20 front-panel BNC connectors in three possible combinations: four groups of four channels, two groups of eight, or one group of 16. Rise time for groups of four channels is approximately 1 ns. Used for scanning and channel switching, this device is remotely controllable over the GPIB.

1360P/1360S
Programmable Signal Multiplexer

This microprocessor-based, programmable, system instrument can be used to multiplex electrical signals. The switch matrix includes four identical nine-pole coaxial switches. Operational modes are determined by adjustable straps. Switch modes are individual gangs of 1, 2, or 4. Multiples of eight inputs can be multiplexed to one output.

GENERAL-PURPOSE INSTRUMENTS

AA 5001/SG 5010
Programmable Audio Test System

This system automatically performs industry-standard tests, i.e., harmonic distortion (IHF A202), intermodulation distortion (SMPTE TH 22.51, DIN 45403, IEC 268.3, IHF A202), frequency response (IHF A202), and noise/signal-to-noise ratio (IHF A202) ("A" weighting filter complies with ANSI spec S1.4 and IEC spec 179 for sound level meters). Option 02 adds noise measurements (CCIR 468-2 and DIN 45405). The SG 5010 also generates the burst signal for dynamic headroom tests.

CG 5001
Programmable Calibration Generator

This microprocessor-based plug-in is an integral part of a controller-based system used to calibrate/verify major scope parameters. Learn mode allows front-panel control settings to be assimilated as program data by the controller. All front-panel settings are remotely controllable via the GPIB.

DC 5009
Programmable Universal Counter/Timer

This dual-channel, microprocessor-based plug-in provides frequency/period measurement to 135 MHz. It features push-button automatic trigger-level setting and eight measurement functions. Arming input permits measurement of selected events within complex waveforms. Opt 01 adds an oven-controlled 10-MHz crystal oscillator. Front-panel settings and features are remotely controllable via GPIB.

DC 5010
Programmable Universal Counter/Timer

This dual-channel plug-in provides frequency measurement to 350 MHz, period, ratio, and event B during A. Trigger levels are automatically set to optimum. Trigger voltage setting is displayable. The DC 5010 has an automatic self-test feature, and is remotely controllable over and fully programmable via GPIB.

DM 5010
Programmable Digital Multimeter

This remotely controllable plug-in measures dc and true RMS ac voltages/resistances. A diode-test function tests semiconductor junctions while a low-voltage/ohms function allows in-circuit measurements without turning on diode or transistor junctions. Math functions include averaging (up to 19,999 readings), dB (ref to 1 mW or to user-supplied constant), comparison, offset, and scaling, or any combination of these functions.

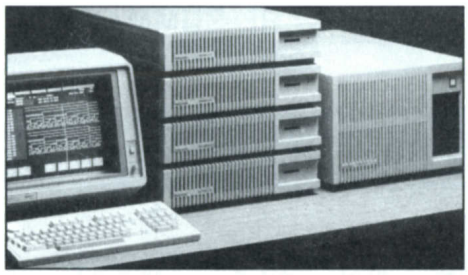
FG 5010
Programmable Function Generator
This plug-in outputs sine, square, and triangle waveforms. Pulses and ramps are provided with variable symmetry in 1% steps. Phase-lock mode automatically locks to any input signal, 20 Hz to 20 MHz. DC offset voltage is programmable from 20 mV to 7.5 V. The FG 5010 can store ten front-panel setups to reduce programming time. Fully programmable via GPIB.

PS 5004
Programmable Precision Power Supply
This TM 5000 Series plug-in provides the high-resolution voltages and currents necessary for characterization of transistor, IC, and other semiconductor/hybrid circuits and in operation of high-performance strain gages and other transducer systems. Its entire 0 to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±0.5 mV resolution without changing ranges. Output is available at the rear as well as from the front-panel. Overall accuracy is ±0.01% ±2 mV.

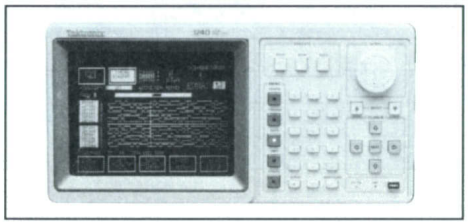
PS 5010
Programmable Triple Power Supply
This supply provides 3 concurrent outputs: two floating (0 to +32 V and 0 to −32 V dc) and a logic level supply (4.5 to 5.5 V dc). Operation includes autocrossover with bus interrupt on continuous-voltage or continuous-current mode change. All three supplies may be remotely controlled over the GPIB (front-panel settings locked out). Overall accuracy is ±(0.5% +20 mV).

LOGIC ANALYZERS

DAS 9100 Series Digital Analysis System
A general-purpose, configurable, and user-upgradable digital analysis system. Available with black and white display (9109 Option 06 mainframe), without display (9119 ATE mainframe), or with color display (9129 Option 06 mainframe). All of the functions that can be accessed from the DAS 9100 Series keyboard may be controlled via GPIB. The I/O Option 06 supports GPIB data rates up to 200K bytes per second as well as RS-232, serial line printers, hard copy units and master/slave operation.

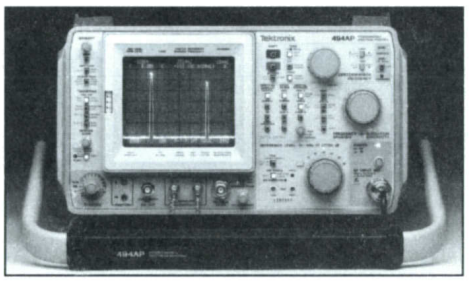


DAS 9200 Series Digital Analysis System Options 1C and 2C
The DAS 9200 expands on all the best - features of the DAS 9100 Series. All operations are menu controlled via a high-resolution color display. The DAS 9200 can be set up and controlled over either RS-232 or GPIB interfaces.

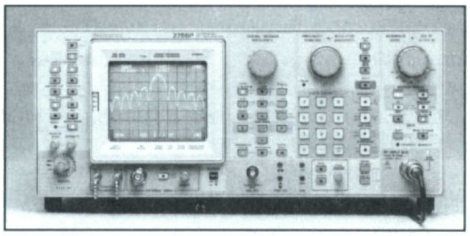


1240/1241 Logic Analyzers
The 1240/1241 support all aspects of the design task, including hardware analysis, software analysis, and integration. For hardware analysis, they offer up to 36 channels of 100-MHz acquisition with 6-ns glitch detection. Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous or asynchronous. A flexible clocking scheme includes data demultiplexing on each acquisition probe. Acquisition, triggering, and display of two independent time bases are tied together, so you can fully monitor the interaction between hardware and software.

PORTABLE SPECTRUM ANALYZERS



2753P (100 Hz-1.8 GHz) 2756P (10 KHz-325 GHz) 2754P (50 kHz-21 GHz) Programmable Spectrum Analyzers
These benchtop analyzers provide laboratory performance combined with ease of use and advanced signal-processing intelligence. Marker keypad functions include Peak Find, Right and Left Next, Next Higher and Lower, Move Right and Left "x" dB, and Find Peak and Center. All analyzers are completely GPIB programmable for increased measurement speed and repeatability. The 2753P and 2756P feature built-in frequency counters and macro recall menus. All four analyzers have nonvolatile memory that stores up to nine waveforms and ten front-panel settings. Spectrum Analyzers Systems software is an option allowing operation with several popular controllers.



492AP 50 kHz to 325 GHz Spectrum Analyzer
This Spectrum Analyzer offers built-in signal-processing intelligence. Marker intelligence provides hands-off convenience for measuring the bandwidth of filters, amplifiers, and other networks. Menu-selectable signal processing enables the analyzer to mark the peak of a main lobe and the peaks of side lobes at the touch of a button. These features and many more are all controllable via the GPIB for measurement repeatability.

495P 100-Hz to 1.8-GHz Spectrum Analyzer
The 495P offers features essential for lab-grade spectrum analysis in a light-weight portable package. This spectrum analyzer incorporates advanced intelligent markers and signal-processing capabilities all controllable via the GPIB. Option 05 provides a precision internal reference, signal counter, external reference input, and macro down-loadable programming capabilities. Frequently used measurement routines can be executed from the analyzer's nonvolatile memory.

494AP Programmable Spectrum Analyzer
This 10-kHz to 325-GHz portable spectrum analyzer provides lab precision measurement capability in hostile field environments. Full control of the front panel, waveform processing, and storage are accessible via the GPIB. The 494P features 10 Hz to 3 MHz resolution, macro downloadable programming capabilities, signal-processing intelligent markers, and a built-in, precision frequency counter to 325 GHz.

SOFTWARE SUMMARY

Information Display Products			
Application	**Product/Function**	**Language**	**Runs on/with**
Terminal Emulation Software	PC05/PC07: PC access to 4105 or 4107 Terminal graphics on mainframe hosts		IBM XT/AT (and compatibles) with the PC4100 coprocessor board
3D/2D Color Graphics	UTek, C, X windows		4330/4230 Family, 4320/4220 Family, 4310 Workstations
Programming Languages	R&D applications in expert systems, natural languages, intelligent robotics, auto programming	Smalltalk-80, Tek Common LISP, QUINTUS PROLOG	4310 Workstations
Applications Software and Standard Tools	PLOT 10: TekniCAD, CADDPORT, TekniCAP, TekPLOT, GSI, PHIGS, STI, GKS, IGL, TCS		4330/4320 Workstations 4310 Workstations VAX, MicroVAX, IBM
Design Automation Products			
Application	**Product/Function**	**Language**	**Runs on/with**
CAE Systems Design & analyze complex electronic circuits	Designer's WorkSystem		Apollo Workstations; DEC VAX Family; Tektronix workstations
VLSI verification and analysis	Gate Array WorkSystem		
Full custom chip design	Full Custom WorkSystem		
Digital Signal Processing	Signal Processing WorkSystems		
Printed curcuit board design	PCB WorkSystem		
CASE Tools Analysis—TekCASE Analyst/ RF Tools	Graphically specify Real-Time system requirements		DEC VAX Family, IBM PC
Design—TekCASE Designer Tools	Graphically specify design requirements		DEC VAX Family IBM PC
Code—Language Directed Editors	C and Pascal language-sensitive editors	C, Pascal	DEC VAX Family, IBM PC
Assemblers	Develop code for all major microprocessors (8, 16, 32-bit)		DEC VAX Family, IBM PC
C Compilers	C Compilers for major microprocessors (16, 32-bit)	C	DEC VAX Family, IBM PC
Pascal Compilers	Pascal Compilers for major microprocessors (16-bit)	Pascal	DEC VAX Family, IBM PC
Test—Emulation Systems	Real Time Emulation for all major microprocessors (8, 16, 32-bit)		DEC VAX Family, IBM PC
Trigger Trace Analyzers	Captures real time software and hardware events		DEC VAX Family, IBM PC
High-Level Debug	Debug code at the C/Pascal source level		DEC VAX Family
Integrate—C-LANDS (C Language Development Systems)	Full C Development Systems for 16, 32-bit microprocessors	C	DEC VAX Family
Pascal LANDS (Pascal Language Development Systems)	Full Pascal Development Systems for 16, 32-bit microprocessors	Pascal	DEC VAX Family
Maintain	All Tektronix software products		DEC VAX Family, IBM PC
Mnemonic Disassemblers	Disassembles data acquired from microprocessor-based system		DAS 9100/DAS 9200 1240/1241
Performance Analysis	Characterizes system performance		1240/1241/DAS 9200
ASIC VLSI Verification	Links DAS 9100/9200 to host for device verification and functional testing. 91DVS, 92DV		VAX 7000 Series/UNIX, VAX and IBM PC

SOFTWARE SUMMARY

Communication Products

Application	Product/Function	Language	Runs on/with
Automatic Video Measurement	Unattended monitoring of NTSC and/or PAL video signals	Tek ANSWER BASIC	1980 ANSWER System
Spectrum Analysis RF Microwave Millimeter-wave	S26RF00—General RF Applications Software Package Measurements, Waveform Operations, Filter Tests, Utilities, Signal Search, Remote Access	Tek 4041 BASIC HP BASIC 3.0 IBM Advanced BASIC 2.1	490P/2750P Series, Tek 4041, HP9816, 9826, 9836, IBM PC/XT/AT
EMI Testing	S26EM00—EMI Prequalification Software FCC/VDE Conducted and Radiated MIL-STD-461B/462 Conducted and Radiated	IBM Compiled BASIC 2.0	490P/2750P Series with IBM PC/XT/AT
Remote-Site Monitoring	S26RM00 Host/Operator's Package S26RM01 Remote Site Package Monitor/Control Multiple Spectrum Analyzers	IBM BASIC	490P/2750P Series

Instruments/Systems Products

Application	Product/Function	Language	Runs on/with
Measurement Software Communication Utilities	TekMAP: S42P101—7854/IBM PC Communication and Control (COMMUTE) PC Utility Software: S47P102—11400/IBM PC S47P103—11300/IBM PC	IBM Compiled BASIC IBM/MicroSoft Compiled BASIC	IBM PC/XT/AT IBM PC/XT/AT
Pulse Parameter Analysis	Time and Amplitude Measurement Software: S42H201—7D20/HP Series 200 S42H202—7854/HP Series 200 S42P201—7D20/IBM PC 062-7732-00 7D20/Tek	HP BASIC HP BASIC 4041 BASIC	HP-216, 226, 236, or 236C HP-216, 226, 236, or 236C Tek 4041, 4000 Series Terminal
Scientific Data Analysis	S42P301—ASYST Scientific Software System/ Graphics/Statistics/Analysis/GPIB Data Acquisition	ASYST	IBM PC/XT/AT or DOS 2.0/2.1/3.0/3.1
Signal Processing and Display (SPD) Program Library	Library of over 190 different signal processing and display programs for IBM PC/10Z210 Fast Fourier Transforms (FFTs), Pulse Parameters, Correlation, Convolution Functions, FIR Filters	Lattice C, IBM compiled BASIC 1.0, menu mode	IBM PC/XT/AT
GPIB Instrumentation Interface	GURU II	IBM PC BASICA	IBM PC (or PC compatible)
Measurement Systems	Languages for Instrument Control, Signal Acquisition, Waveform Processing and Graphics	SPS BASIC 4041 BASIC	Micro/PDP-11 4041
Single-Shot Acquisition to 750 MHz BW	MS 3101—Waveform Acquisition, Signal Analysis Support for 7912HB	SPS BASIC	Micro/PDP-11 with 7912HB
Single-Shot Acquisition to a 200 MHz Sample Rate	MS 3201—Waveform Acquisition, Signal Analysis Support for 7612D	SPS BASIC	Micro/PDP-11 with 7612D
Single-Shot Acquisition to 750 MHz BW	MP 2101—Waveform Acquisition, Signal Analysis Support for 7912HB	4041 BASIC	4041 with 7912HB
Single-Shot Acquisition to a 200 MHz Sample Rate	MP 2201—Waveform Acquisition, Signal Analysis Support for 7612HB	4041 BASIC	4041 with 7612D
Acquisition to 14 GHz BW with Sampling Plug-Ins for Repetitive Signals	MP 2501—Waveform Acquisition, Signal Analysis Support for 7854 including Sampling Applications and TDR	4041 BASIC	4041 with 7854
Single-Shot Acquisition to a 100 MHz Sample Rate and 150 MHz BW for Repetitive Signals	MP 2601—Portable Measurement Package providing Waveform Acquisition, Signal analysis for 2430	4041 BASIC	4041 with 2430
Single-Shot Acquisition to a 200 MHz Sample Rate with 100 MHz analog BW	MP 2701—Waveform Acquisition, Signal Analysis Support for RTD 710	4041 BASIC	4041 with RTD 710
General-Purpose Instrument Test Development Tool	TEK EZ-TEST	4041 BASIC	4041
Audio Test Development Tool	MP 2902—Tek Audio TPG	4041 BASIC	4041
Miscellaneous Waveform Acquisition, Signal Processing, etc.	Tekware™ Instrument Software Library	4041 BASIC, IBM BASIC, Turbo Pascal, and others	2220, 2230I, 2430, 7D20, 7854, 370, 7612D, 7912HB, RTD 710, and others*[1]

*[1] *Contact your local Sales Engineer.*

COMPONENT DIVISIONS & PRODUCTION SERVICES

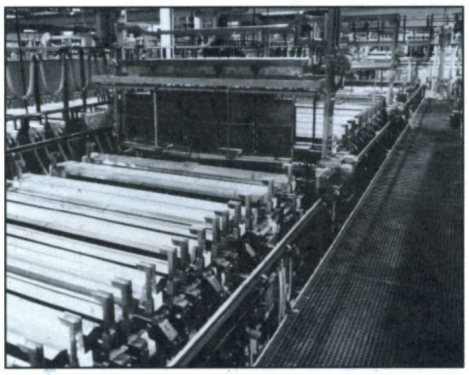
CONTENTS

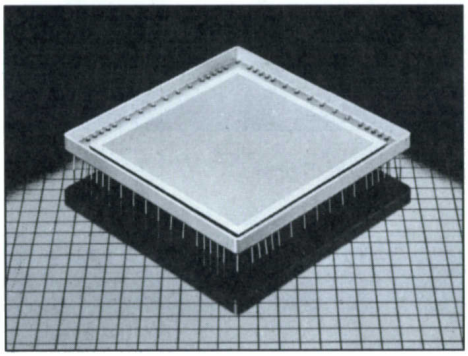
Circuit Board Manufacturing 29
Flexible Circuits 30
Teflon Circuit Boards 30
Metal Products 31
Integrated Circuits 32
Microlithography Products 33
Hybrid Components 34
Display Devices 36
Avionics Color CRTs 36
Touch Panels 37
Display Monitors 39

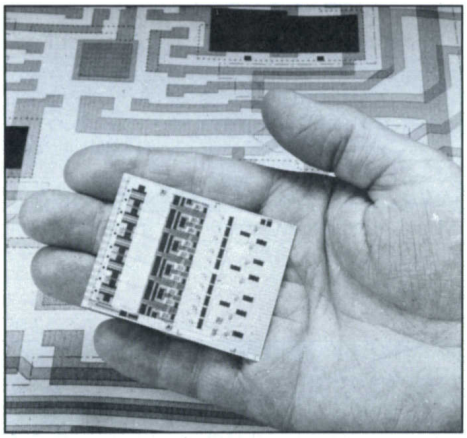
Tek's world-class facilities and know-how at your disposal.
We know that your systems can only be as reliable as the components that go into them. For that reason, we place a premium on dependability. We produce products that will keep you and your customers satisfied and your service costs down.

We take your design (or assist you with design) and take the entire process through manufacturing and shipment. Quality control is assured, along with on-time delivery and customer satisfaction. We want to work with you and value you as our customer.

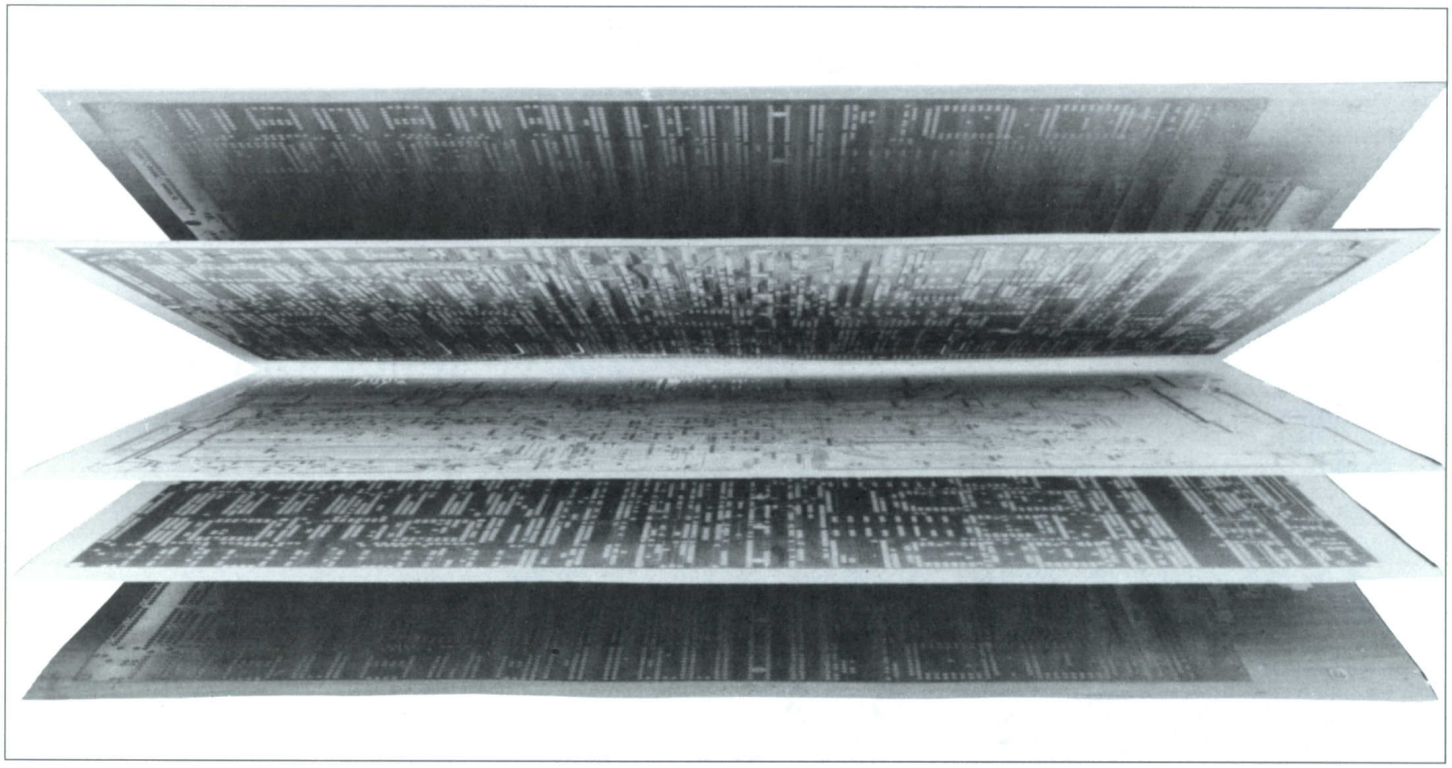
Tek's special application components now available for use in your latest product design.
Now you can increase the productivity of your design team by specifying custom components designed and manufactured by Tektronix. We've made them to our exacting specifications and quality standards. You can depend on it. Contact one of our plants directly.







Design, Manufacture, Test, Ship . . . We do it all!



Circuit Board Manufacturing

- Technology
- Quality
- Service

Tektronix Circuit Board manufacturing offers you a competitive advantage in bringing your high-technology products to market and keeping them there.

TECHNOLOGY

High-Quality Multilayers—We specialize in high-quality multilayers backed by a Tektronix warranty.

Fine-Line Circuits—Our tight tolerances and precise registration accuracy provide high-quality fine-line circuits with track widths of 0.006 inch and greater.

Hot-Air-Leveling—Our state-of-the-art horizontal hot-air leveling system eliminates process variability and ensures component solderability.

Electrical Characteristics—We fabricate and test circuitry with impedance control tolerances to ±3%. Consultation is offered in proper lay up and material selection for tightly toleranced 50 and 75 Ω circuitry.

Laser Film Generation—We use customer supplied CAD and N.C. databases to create tooling that provides ultimate feature and registration accuracy and maximum accuracy between laser generated artwork and N.C. drill programs.

Surface Mount—If you are ready to incorporate surface-mount technology in your next product, we offer a wide range of technology and support services from design consultation to high-quality fine-line or blind and buried via multilayers.

SERVICE

New Product Support—Design consultation, value engineering, and prototype support are just some of the services provided by Tektronix Circuit Board manufacturing, which can improve your time-to-market and the cost effectiveness of your design.

Delivery—Our delivery performance is unequaled in the circuit board industry. Ours is the first Class "A" MRP-certified circuit board plant in the world, an accomplishment that assures on-time delivery to our customers.

CAPABILITIES

Number of Layers—2 to 10 plus.

Standard Material—FR-4, CEM-3.

Density—0.006 in. spacing; conductor width: 0.006 in.

Finishes—Bright tin, gold, hot-air-leveled solder.

Soldermasks—Screened thermal-cured epoxy, 0.003 and 0.004 in. Vacrel aqueous dry film.

Standard Panel Sizes—12×18 in., 18×18 in, and 18×24 in.

Finished Board Thickness—Maximum 0.090 in, minimum 0.030 in.

Tooling—Computer-aided, laser-generated film.

Testing and Analysis—Complete in-house electrical, metallurgical and chemical testing.

Finished Hole Size—Minimum via 0.018 in.

Aspect Ratio—3:1 vias.

Annular Ring Over Drill Size—Circuit pad: 0.005 radius; Clearance pad: 0.012 radius.

Flexible Circuits

- **High Density**
- **High Reliability**
- **Versatile**

Flexible circuits are solving increasingly complex packaging needs required by todays high-density, compact instruments in the areas of digital interconnects, wire-harness replacement, and specialty applications.

Patented design techniques are used by Tektronix to achieve controlled impedance, low-capacitance electrical performance. Flexible circuits simplify the interconnection without sacrificing high circuit density or reliability. UL recognition available for flexible circuits and multi-layer flexible circuits with a flammability classification of 94 V-O.

Advantages of Tektronix Flexible Circuit Manufacturing Processes

- Production fine-line capabilities
- Use of thin dielectrics
- Proprietary strain relief for improved mechanical reliability
- Use of Teflon coversheets for increased flexibility and ruggedness

We offer a full-service package from design support through prototypes, to production. We prefer to participate early in the new product introduction to achieve a product that meets or exceeds the desired electromechanical properties, and is economically manufacturable.

TYPICAL SPECIFICATIONS

Front to Back Registration—± 0.0005 in.
Smallest Line Width and Spacing—0.004 in.
Line Width Tolerance—0.0005 in.
Hole-to-Hole Distance—0.050 in.

Customer Support
Tektronix, Inc. P.O. Box 500, D.S. 38-330
Beaverton, OR 97077
(503) 627-2000

Teflon Circuit Boards & Hypcon Connectors

- **Low Dielectric Constant**
- **Dimensional Stability**
- **Controlled Impedance Lines**
- **Close Tolerances**

The utilization of higher frequencies (>1 GHz) in the field of communications and data transmission has accented the need for accurately-tuned transmission lines and high-performance Hybrid Circuit Connectors.

The low dielectric constant, dimensional stability and close tolerance requirements of these circuit designs make Teflon-based substrates an essential material for circuit board applications. Certified by UL for recognized Teflon printed wiring boards, flammability classification is 94 V-O.

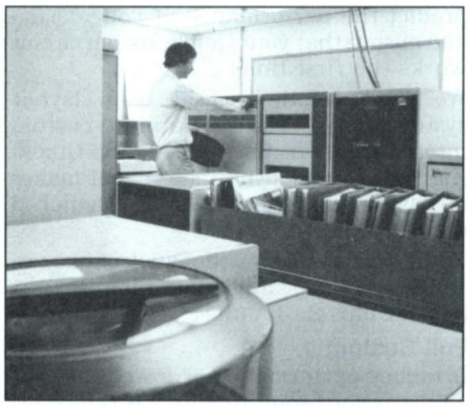
TYPICAL SPECIFICATIONS

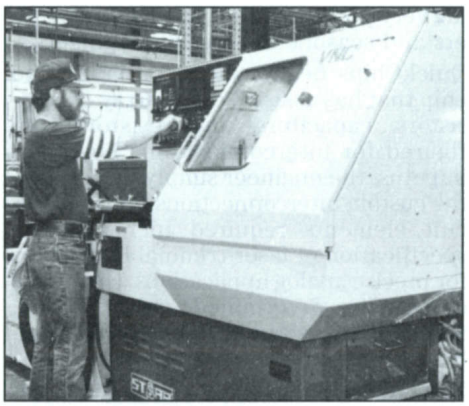
Operating Frequencies—>10 GHz.
Dielectric Constant—2.17-10.6
Std. Dielectric Thickness—0.002-0.062 in.
Production Process Dimensions—
Multilayers Registered to: ±0.0004 in.
Line Widths and Spacing to: 0.0004 in.
Line Width Tolerance to: ±0.0005.
Line Width Tolerance to: ±0.0005 in.
Front-to-Back Registration to: 0.0005.

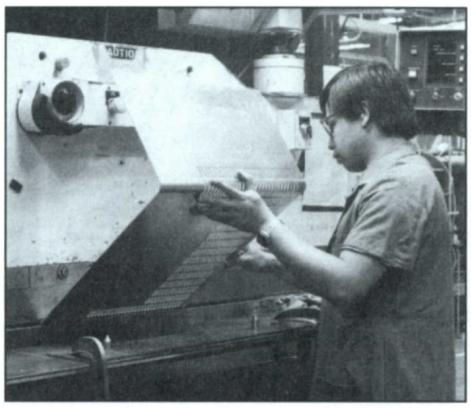
Hypcon™ Connector

Hypcon is the trademark for a metalized elastomer connector used by Tektronix to mate hybrid circuits to PWB's. Hypcon connectors perform at frequencies greater than 10 GHz. Contact spacing is from 0.01 inch on 0.03 inch centers.

Customer Support
Flexible Circuits, Teflon
CBs and Hypcon Connectors
Tektronix, Inc. P.O. Box 500, D.S. 38-330
Beaverton, OR 97077
(503) 627-2000







Metal Products

- **Tool and Design**
- **Manufacturing**
- **Quality Control**
- **Packaging/Shipping/JIT Delivery**

Tektronix offers complete metal products capabilities from Tool and Design through manufacturing. Quality control is assured and products are shipped to customer satisfaction.

MANUFACTURING CAPABILITIES

Tool and Design—Full design and documentation capabilities, with a tool room equipped to build and maintain most types of tooling.

Machining—Screw machines, sawing, and CNC milling with machine-aligned cellular processes.

Sheet Metal—Sanding, blanking, piercing, turret punching, shearing, forming, grinding and buffing of various material types including: aluminum, copper alloys, brass, and stainless steel.

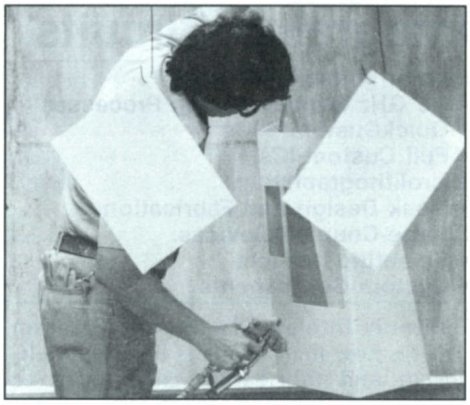
Programming—Full programming capabilities are available for sheet metal processes and machining.

Hardware Assembly—Includes riveting, hardware insertion, spotwelding, gluing and complete enclosure assemblies.

Finishing—Includes auto and hand paint; (color matching lab). Etch, lacquer, chromate, silk screening, and printing with full nomenclature capabilities.

Packaging and Shipping—All items packaged and shipped to customer satisfaction.

Quality Control—All work areas are fully equipped with the latest state-of-the-art equipment and technology.



EQUIPMENT LIST

Quality Control—Programmable measuring system by Brown & Sharpe (0.00025 in. obtainable measurements)

Programming—MEG 131 Graphic Terminals coupled to VAX 11/780 system.

Production Machining
- CNC screw machines
- CNC milling machine—horizontal/vertical
- CNC bar and chucker
- Automatic screw machines
- Belt sanders
- Vibratory finishers
- NC drillers
- Grinders
- Saws

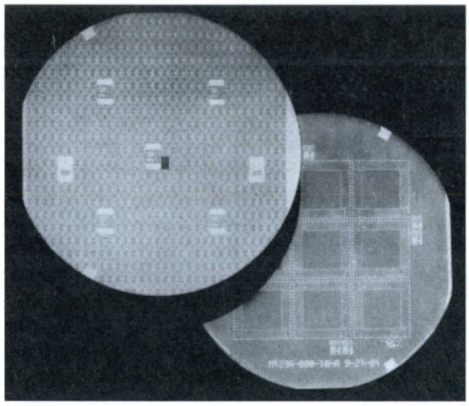
Sheet Metal
- Shears
- Punch presses, 0-300 ton
- Power brakes, 12-55 ton, automatic back gauges
- Spotwelders, 30 kVA-250 kVA
- Heli-arc welders

Hardware Assembly
- Presses, 2-8 ton
- Auto-press nut machines
- Eyelet machines
- Riveters
- Insertion machines
- Cabinet latch machines

Finishing
- Chromate coat, to MIL-C-5541 (clear & yellow)
- Automated etch line
- Ultrasonic clean
- Variety chemical baths
- Automated electrostatic paint line (Ransberg Disc)
- Automatic silk-screen machines
- Automatic printing press

Tool/Die
- Jig bore
- EDM
- Grinding
- Lathes, mills and drills

Customer Support
Metal Products
Tektronix, Inc.
P.O. Box 500, D.S. 16-158
Beaverton, OR 97077
(503) 627-6000
FAX 627-4370



Integrated Circuits

Bipolar Foundry Services:
- **6.5 GHz Bipolar Analog Processes**
- **QuickCustom™ ICs**
- **Full Custom ICs**

Microlithography:
- **Mask Design and Fabrication**

Charge-Coupled Devices:
- **Scientific Imagers**
- **Custom Components**

Tektronix Integrated Circuits Operation (ICO) is now marketing its formidable IC design and fabrication capabilities to those who have IC performance requirements but limited resources.

Tek ICO has been supplying ICs with high performance, superior quality, and proven reliability to Tektronix' product divisions since 1967. Our integrated circuits continue to provide important technological and market advantages for many state-of-the-art products. Our foundry services for analog application-specific designs are now available. In addition, a limited number of specialty components for high-performance applications are being offered on a contract basis.

Since we've developed advanced imagers for high-resolution scientific imaging and high-speed signal processing, we can supply you with custom charge-coupled devices (CCDs) for these applications. The development of Tektronix high-performance components required development of very sophisticated microlithography and high-resolution, fine-quality, VLSI mask-making services, which are also available.

BIPOLAR ANALOG ICs

Two design methods are used to manufacture custom analog ICs: QuickCustom and full custom.

QuickCustom™

A semicustom design approach, QuickCustom™, helps reduce your development time and cost. It consists of a series of QuickChip™ design formats and easy-to understand, time-saving design tools. This abbreviated design method is becoming very popular with first-time IC designers and seasoned IC design engineers.

QuickChips begin with a prefabricated chip that has a basic "core" array of transistors, capacitors, and resistors configured for interconnection. Given this impetus, the engineer simply determines the custom interconnections for those circuit elements required including the specification of laser-trimmable resistors for precise analog applications. Once final designs are determined and approved, finished wafers can be delivered (typically) within three weeks or less.

This "designer-friendly" approach was developed by Tektronix engineers who have many years of analog expertise in IC design. Their mastery of integrated analog circuit design and demonstrated experience have streamlined the design process. Today ICO engineers are ready to provide you with as much assistance as you require. The "tools" include a complete guide enabling the first-time user to complete a design with minimal one-on-one coaching. We provide you with a library of macro cells (QuickChip 4), and SPICE models for the "core" IC that will predict the performance of your design and ensure that your QuickCustom circuit works the first time.

We also include a grid-based layout system that specifies where the custom interconnects can be routed, and QuickKic™, a graphic layout editor that makes it easy for even the first-time designer to digitize the layout.

Typical ICO-developed QuickChips are shown in the adjacent photographs (QuickChips 2, 3 and 4).

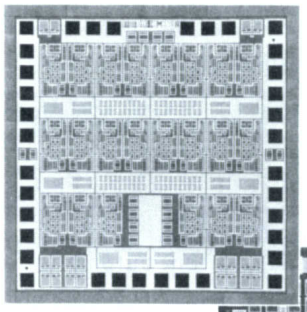
Full Custom

If higher performance or lower cost per chip are your requirements, ICO also offers a total-custom-design approach. One of our experienced applications engineers will be assigned to work with you or your team throughout the entire project. Tektronix QuickChip 4 developed CAD/CAE software will be used to assist you through circuit analysis, simulation and layout, greatly improving your confidence in meeting design specifications the first time. Typical delivery of finished wafers is less than eight weeks from approval of design layout.

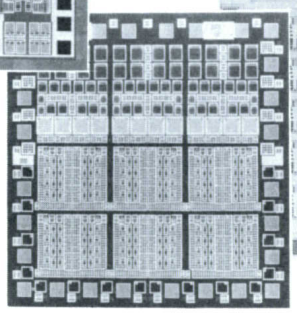
THE QuickChip FAMILY

	NPNs*1	f_T	Max V_{CC} to V_{EE}	Resistors	Capacitors	Chip Size	Bonding Pads
QuickChip 2 Family	142–524	6.5 GHz	32 V	2046 implanted Thin Film, 10 or 50 Ω/sq*2	≤20 pF	1.98×2.49 mm to 4.09×4.19 mm	24–70
QuickChip 3	168	2.4 GHz	95 V	684 Implanted Thin Film, 50 Ω/sq*2	≤16 pF	2.97×3.05 mm	28
QuickChip 4	294	6.5 GHz <400 ps t_{pd}	32 V	1290 Implanted Thin Film, 50 Ω/sq*2	32 Programmable ≤59 pF	4.9×4.9 mm (196 mils²)	30A 36D

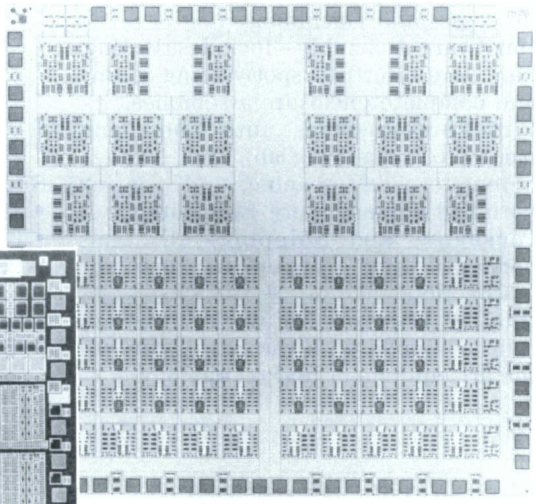
*1 *PNP transistors are also included in QuickChips 3 and 4. The f_T of PNPs is approximately 30 MHz, and they are optimized for use as current sources (i.e., low collector capacitance).*
*2 *Laser trimmable*



QuickChip 2

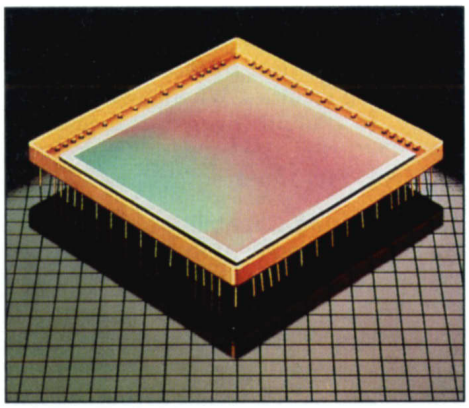


QuickChip 3



QuickChip 4

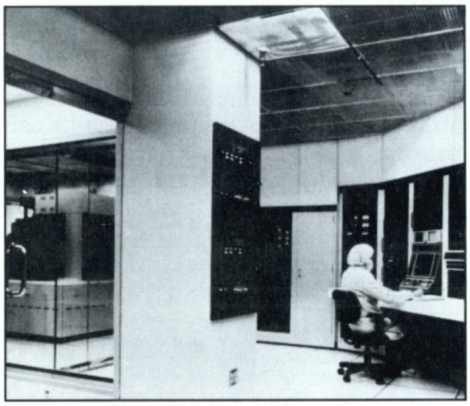
QuickCustom and QuickChip are Tektronix trademarks.



Microlithography Products And Design Services

Mask Design

From minimally supported system time to full-device design, our microlithography facilities are structured to meet your mask design needs. Working from menu-based design technology and grid-based layouts, we provide QuickChip™ and gate array designs plus full custom, application-specific analog and digital ICs. We use mask design tools to support development of nonstandard products. Routine efforts include designs for thick- and thin-film hybrid circuits, multilayer ceramic parts, waveguides, precision mesh components, liquid-crystal and electroluminescent panels, graticules, and small chemically milled parts. Also, we are used to accommodating unusual requirements; we can handle yours.



Mask Fabrication

The same commitment to customers' needs is evident in our support of mask tooling. Our state-of-the-art facility can meet all of your photomask needs. Class 10 clean room conditions are constantly maintained in critical manufacturing areas. Our technicians demonstrate the expertise and versatility to support the wide variety of work our Mask Design group creates; from 10X reticles to 1X VLSI wafer-scale integration masks. This part of our facility includes both G.C.A./D.W. Mann optical systems and Perkin-Elmer Electron-Beam equipment. Our staff will work with you on an individual basis to determine which design approach will meet your requirements and still be economical.

Our present capability provides tooling from 2½ by 2½ inch up to 7 by 7 inch glass substrates with a variety of thicknesses. We supply critical feature control from millimeter to submicron sizes, with position accuracy as small as 0.125 microns. Our claim of high-quality products is backed by equipment such as Leitz MPV-DC and Nikon MPA-2A measurement systems. A Nikon CM-6 overlay comparator, Quantronix repair station, and KLA and Cambridge mask inspection systems, ensure that we deliver a superior product on time every time.

CHARGE-COUPLED DEVICES

Charge-coupled devices (CCDs) are MOS integrated circuits that are essentially sampled data, analog delay lines. Used in such diverse applications as ultra-sensitive imaging detectors, transversal filters, tapped analog delay lines, and high-speed samplers and memory buffers, these inherently simple devices have proven to be powerful yet compact signal processing components.

For more than three years the CCD group at Tektronix has been developing a specialized set of devices to incorporate signal processing efficiency into Tektronix instruments. In the process we have developed one of the most advanced CCD technologies in the industry. This technology is available through a line of CCD products and design services.

Tektronix has developed two families of large pixel, array imagers with the CCD processes. Designed for low noise, wide dynamic range, high charge transfer efficiency, low dark current, and high sensitivity, the scientific family consists of the TK512M and the TK2048M devices. They are normally used cooled and at low scan rates. The TK2048M Imager shown has 4.2 million picture elements, each of which is approximately 50 times more sensitive than high-speed photographic film. The high-frame-rate family consists of smaller arrays that run from 100 frames per second to 5,000 frames per second image rates. They are normally used at room termperature and high scan rates, but still maintain comparatively low noise, and wide dynamic range. Any of the family is available in a mechanically stable, thinned, back-illuminated version for higher quantum efficiency in the visible range and extended response in the ultraviolet wavelenghts.

Custom Devices

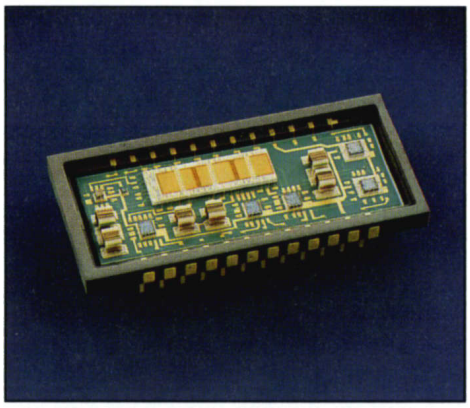
For custom designs our CALMA-based, state-of-the-art CAD system, advanced microlithography capability including wafer-scale E-beam mask making and three- or four-phase CCD processes make it possible for you to design virtually any type of signal-processing device. You can specify nearly any format of serial-parallel-serial CCD structures, optimized either for high speed or wide dynamic range, imaging or nonimaging. We also provide design and fabrication support for certain types of peripheral circuits including wide-band preamplifiers, high-speed clock drivers, correlated-double-samplers, and timing/control logic.

If you've already completed a CCD design, Tektronix ICO provides a complete CCD foundry service to fabricate your device(s).

For further information, call:
ICO Marketing
Tektronix, Inc.
P.O. Box 500, D.S. 59-420
Beaverton, OR 97077
(503) 627-2515

Hybrid Components

Tektronix HCO offers you its design and manufacturing expertise for innovative, precision custom hybrid components. Thick-film, thin-film, multilayer ceramic, and electro-optic technologies are available.



Engineering Services

Our experienced engineering support could begin at any phase of your design development; from the implementation of your design to working from your "blackbox" specifications.

Prototyping

HCO's prototype methods and process flows are identical to those used in our production facilities. When engineering is ready to "hand over" a design to manufacturing, the transition is smooth, efficient, and timely.

Manufacturing Capabilities

We operate with fully characterized "systems" of compatible materials and process.

The latest production improvement methods are used here, including Just-In-Time, Class "A" Materials Resource Planning, some clever ideas of our own, and a well-defined New Product Introduction system supported by complete, precise documentation.

Test and Trim

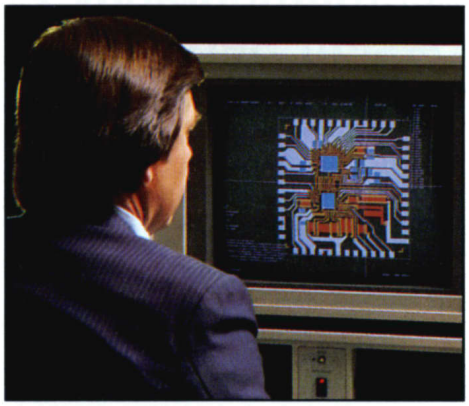
Our test/trim development ensures project quality by the generation of fixtures and software for passive laser trimming, functional hybrid testing, and functional laser trimming with dynamic parameter adjustments.

Thin-Film Hybrids

If your applications include microwave, high-power, or precision circuitry, our thin-film hybrids should be considered. They offer small geometries for increased circuit density and reduced parasitic inductance and capacitance. Typical limits of our capability are 20 μm line widths ± 1 μm, laser-trimmed resistors of up to $\pm 0.05\%$, ratio temperature coefficient of resistance of $+5$ ppm/°C, two layers of conductors, and the ability to braze Kovar heat sinks to devices.

Thick-Film Hybrids

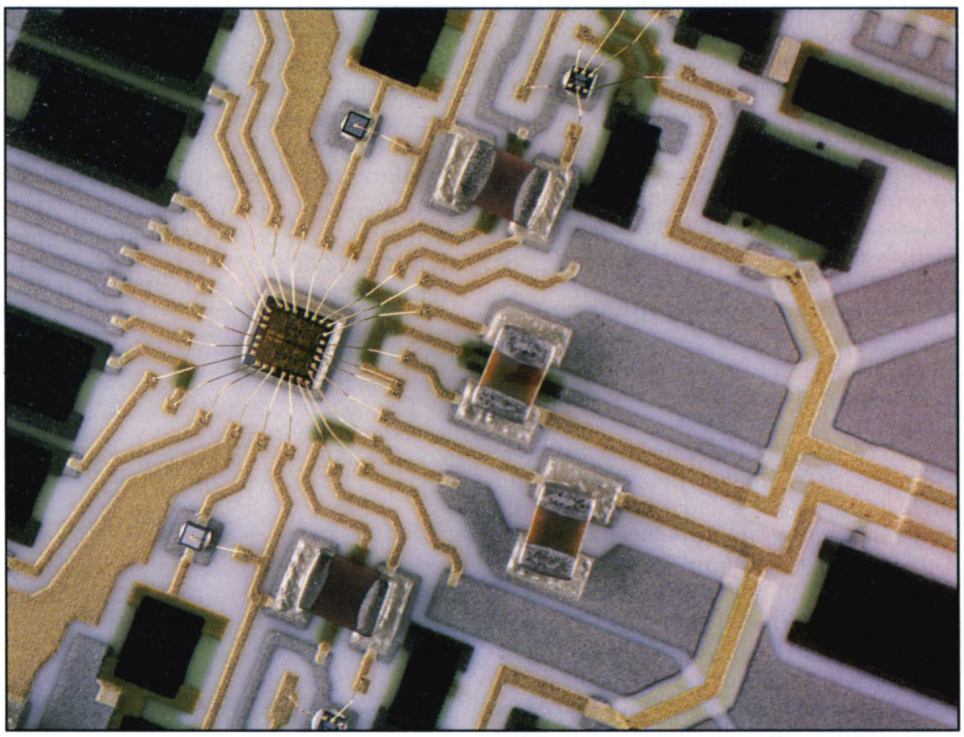
For medium complexity, high resistor count, or special time adjustment applications, thick-film circuits are a cost effective choice. We offer multilayer thick-films, surface-mount assemblies, and chip-and-wire assembly to achieve typical densities of 25 components per square inch. With careful design, they can be used up to 2 GHz.



Multilayer Ceramics

The conductor features of MLC may be as fine as 4-mil lines and 3-mil spaces. These geometries provide high-density circuit interconnect capabilities. In addition, ground planes can be used to isolate high-frequency signal lines, and the thickness of the dielectric layers can be adjusted to provide a designed line impedance.

By adding components in chip form to the MLC surface layer, complete circuits can be formed. Our processes have been used to build rugged, high pincount VHSIC-type chip carriers.



From our modem MLC laboratories, we offer you:

- VLSI/VHSIC packages with 264 pins and more
- Integrated computer-aided design and manufacturing
- 4-mil line and 3-mil space layouts
- 5-mil vias
- Shrinkage control consistently with 0.5%
- Fired tape flatness camber control that exceeds industry standards by at least 100%

Electro Optics

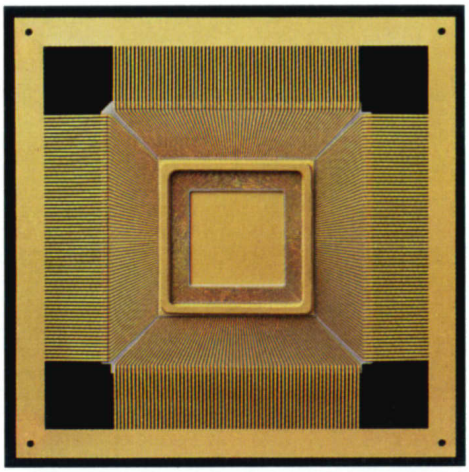
Tektronix is rapidly building a family of electro-optics standard products for communication applications. Consider, for example . . .

Our standard product LDM 1301 is a general-purpose, high-performance laser diode module that is a direct plug-in replacement for the 14-pin, dual-in-line, industry-standard package. This laser is ideally suited for either digital or analog applications, and it features high-output 1300 nm single-mode emission through either a fiber pigtail or an optical connector. The package includes a photodiode to monitor back-facet emission and a precision thermistor to monitor and control package temperature. It can be purchased with or without a thermal electric cooler.

High coupling efficiency from the laser to the fiber is created by using a proprietary fiber lensing process. With this technique, single-mode optical powers of 2 mW are typically provided.

Our latest additions to the family of electro-optic products are two polarization retaining single-mode 1300-nm laser diode modules. These devices are ideal for a wide variety of performance and environmental applications, including test and measurement instruments, fiber gyroscopes, R&D, military systems, and optical sensors.

The LDM 1300PR is an exceptionally small, rugged 8-pin DIP package with complete functionality, including laser, thermistor, and monitor diode, while its companion polarized fiber module, the LDM 1301PR, is a pin-compatible, industry standard, 14-pin DIP. Both packages are hermetically sealed in an inert environment containing neither epoxies nor organic compounds. This assures a reliable, highly stable operating lifetime for the products.



Doing Business With Us

We would be pleased to discuss your needs for custom or standard hybrid components and to quote on your requirements. We welcome visits to our plant to consult with our design and production staff and to tour our facilities.

Our Goal Is:

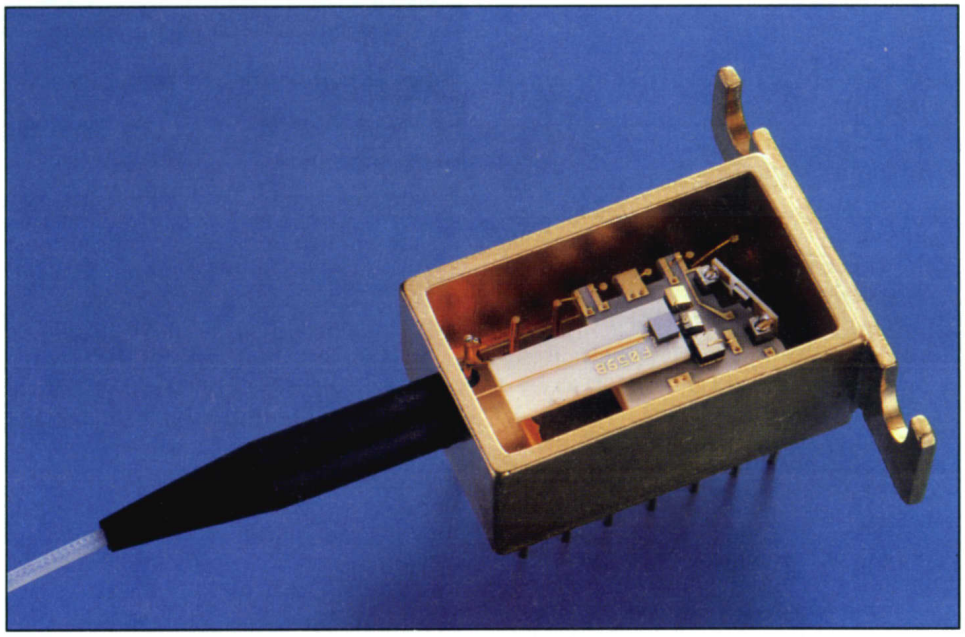
- 100% Quality
- On-Time Delivery
- Unsurpassed Service

For More Information Please Call:

Customer Support
(503) 627-4220

Or Write:

Customer Support
Hybrid Component Operations
DS 13-810
Tektronix, Inc.
P.O. Box 500
Beaverton, OR 97077



Built on 36 years of experience in the design and manufacture of advanced-technology magnetic and electrostatic CRTs

For the first time, Tektronix-proven quality, reliability, and performance are available for your CUSTOM CRT needs.

Ultra-High Resolution
- Photographic Imaging
- Medical/Diagnostics
- Workstations

High Brightness
- Avionic Color
- Color Shutters
- Air Traffic Control

Ruggedized
- Mobile Military
- Cockpit Displays
- IR Viewers

Hard Copy CRTs
- Fiber-Optic Faceplates
- Ceramic Funnels
- Various Phosphors

Avionics Color
Cathode-Ray Tubes

- **High Resolution**
- **Sunlight Readable**

Breakthrough mechanical design has resulted in a family of high-quality shadow-mask color display tubes equally adaptable to both raster-scan and stroke-written modes of operation.

These daylight-bright high-resolution ruggedized CRTs are intended for aircraft cockpit multipurpose color displays. All tubes meet or exceed the emerging requirements for EFIS display systems, including MIL-STD-810C for shock and vibration.

The Tektronix Avionics Display organization will quote, upon request, design considerations involving phosphor composition, tube size and shape, and complete assemblies.

Customer Support
Avionic Displays
Tektronix, Inc.
P.O. Box 500, D.S. 48-255
Beaverton, Oregon 97077
(503) 627-6882
or 1-800-835-9433 ext 6868
Telex: 151754
TWX (910) 467-8708

Monochrome
Cathode-Ray Tubes

High Brightness
Proprietary high-beam-current electron-gun design and optimized phosphors provide a unique combination of brightness and resolution. A brightness of 11,991 cd/m² (3500fL) at 768×1024 pixel resolution is achievable in a 9-inch display.

A clam-shell yoke design and low grid-drive capacitance provides low power consumption and high deflection sensitivity.

High-Resolution Direct View
Our unique electron gun design, dynamic focus, and astigmatism correction elements provide optimum resolution over the whole screen.

Resulting spot sizes approach the resolving power of the human eye at a viewing distance of 24 inches. Our patented low-capacitance grid structures allow the display designer to utilize this resolution capability.

Ultra-High Resolution
Tektronix state-of -the-art capabilities in phosphor formulation and deposition provides the low-blemish, high-uniformity screens necessary for critical display applications. Spectral output can be optimized for photographic and other requirements.

Our gun designs are capable of achieving spot sizes of less than 0.001 inch in screen sizes up to 9 inches. Internal correction elements maintain a uniform spot size over the entire screen.

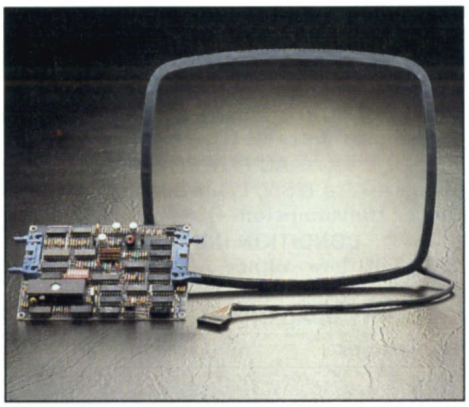
Low Cost
An ultra-modern, high-volume CRT manufacturing facility makes instrumentation-type CRTs available at a low cost. All CRTs feature quality, reliability, low power and high performance with bandwidth from dc to hundreds of megahertz in display sizes to 7 inches.

Customer Support
Monochrome CRTs
Tektronix, Inc.
P.O. Box 500, D.S. 46-539
Beaverton, Oregon 97077
(503) 627-6868
or 1-800-835-9433 ext 6868
Telex: 151754
TWX (910) 467-8708

Hard Copy
Cathode-Ray Tubes

- **Ceramic funnels provide light, strong envelopes for optimum fiber optic faceplate tubes for hard-copy applications. These CRTs use high-resolution, magnetic-deflection electron guns. CRTs with various phosphors can be built for special applications.**

Customer Support
Hard Copy CRTs
Tektronix, Inc.
P.O. Box 500, D.S. 46-539
Beaverton, Oregon 97077
(503) 627-6868
or 1-800-835-9433 ext 6868
Telex: 151574
TWX (910) 467-8708



TekTouch™

Continuous Capacitive Touch Panel

- **High Touch Resolution**
- **High Transmissivity**
- **Rugged and Reliable**
- **RS-232 or Parallel Interface**
- **UL Certified for Data Processing (UL 478), Test and Measurement (UL 1244), Medical, and Dental (UL 544), Vending (UL 22), and Amusements (UL 51)**

TekTouch™ Capabilities

TekTouch allows simple interactive communication between an operator and an electronic system. Versatility of the TekTouch system provides easy access to even the most complex data input requirements.

Soft keys can be defined up to 256 points per axis. TekTouch electronics will compute and transmit touch locations to the host system. TekTouch links to your computer through either RS-232C or parallel interfaces.

The Technology

TekTouch consists of a thin, continuous, transparent layer deposited on a glass panel. The touched position is determined by measuring changes to a small ac signal applied to the touch panel. Variations in the signal correspond to the touch location.

TekTouch's panel construction eliminates many visual distortions commonly found in other touch panels. Minimum parallax error and the panel's 85% transmissivity allow excellent optical clarity.

TekTouch, engineered at Tektronix, provides a reliable, low-cost, data-entry solution.

Installation

TekTouch conveniently mounts under the present CRT/monitor bezel, requiring only about 0.20 inch clearance. The controller circuitry fits on a 4 by 6 inch circuit board designed to mount directly inside the monitor. A harness connecting the panel and controller board is supplied.

Applications

Built to withstand environments such as process control stations, automatic teller machines, and public information kiosks, TekTouch is also a valuable aid for many test and measurement applications. Other uses include:

- Menu selection
- Interactive graphics
- Programmable 'soft keys' for display front panel or as existing keyboard extension

CHARACTERISTICS

Technology—Continuous capacitive.
Touch Resolution—Up to 256 points per axis to panel edge.
Touch Accuracy—Standard error—nominally 1% of panel size.
Touch Sampling Rate—50 to 100 samples per second.
Touch Response Time—20 msec, typical.
Transmissivity—85% at 400 to 700 nm (typical of antiglare-etched surface).
Size Range—9 to 20 inches (228 to 508 mm) diagonal.
Active Touch Area—Within 0.75 inch (19.05 mm) of panel edges.
Input Volts—+5, +12, −12 Vdc.
Glass Thickness—0.125 inch (3.175 mm).
Panel Mounting Accommodations—Gasket supplied with tabs, clips, or mounting tape as appropriate.
Mating Interface (J1) Connector—Berg 66900-220 or equivalent.
Controller Board Mounting Accommodations—Designed to mount with 15 inches (381 mm) of TekTouch Panel.
Certifications—Standard: UL 1244, UL 478, UL 544 (Professional). Optional: UL 544 (Patient care), UL 22 (Vending), UL 51 (Amusement).

COMMUNICATIONS FORMAT

RS-232C Interface—Selectable Baud Rate—1200, 9600, 19200.
Transmission Code—Asynchronous ASCII, selectable parity.
Data Structure—X,Y,Z; 8-bits binary or 7-bit hex ASCII selectable.

PARALLEL INTERFACE

Transmission Code—Binary.
Data Structure—8-bit data with strobe and acknowledge lines.

OPERATING MODES

Data Transmission Modes—User selectable through setting of DIP switches on circuit board.

DATA FORMAT OPTIONS

Alternative data formats available. Please consult Tektronix Display Devices Operation Marketing & Sales for quotation and availability.

ENVIRONMENTAL

Operating Temperature Range—0 to +70°C.
Storage Temperature Range—−62 to +85°C.
Operating Humidity Range—Up to 95% at 55°C.
Moisture and Dust—Resistant to high humidity environments, moisture and dust: highly resistant to the corrosive effects of beverage spills, etc.
Altitude—Operating: Up to 15,000 ft (4.5 km). Storage: Up to 50,000 ft (15 km).
Vibration—Operating: 0.025 in. (0.635 mm) p-p, 10-55 Hz. Storage: 0.05 in. (1.27 mm) p-p, 10-55 Hz.
Shock—Operating: 50 g peak acceleration. Storage: 100 g peak acceleration.

ORDERING INFORMATION

TekTouch™—Standard OEM Product
Includes: Panel and controller board with either RS-232-C and parallel interface.
Evaluation Kit
Includes: Panel, appropriate mounting scheme, controller board, external power supply, controller board cable, external interface cable (DB 15 to DB 25) and Technical Reference Guide.

Customer Support
Tektronix, Inc.
Display Devices Operation
Marketing & Sales
MS 46-539
P.O. Box 500
Beaverton, Oregon 97077
(503) 627-6868
FAX (503) 627-2670

Panel Dimensions

Nominal Diagonal	Spherical Radius (inches)	Height (inches)	Width (inches)	Corner Radius (inches)	Sample Monitors
9 in.	24.0	6.4	8.4	0.75	IBM Portable PC
	27.0	6.1	8.1	0.75	Compaq II Portable PC
12 in.	19.0	8.5	10.6	1.25	IBM 5151
13 in.	22.8	9.5	12.3	1.00	IBM 5154 Zenith ZVM 135 NEC Multisync
	24.0	9.4	12.3	1.12	IBM 5153
19 in.	35.0	13.4	20.4	1.00	Mitsubishi 9920

GMA201

19 in. Monochrome Raster Display Monitor

- **Ultra-High-Resolution Video for the System Builder**
- **Bright, Stable, Noninterlaced 60 Hz Refresh**
- **200 MHz Video Amplifier Bandwidth**
- **ROM-Based Dynamic Focus**
- **Modular Construction for Easy Field Service**

Unparalleled Raster Scan Video Performance

The GMA201 is an OEM product that is well suited to system builders in the fields of gray-scale imaging, CAD/CAM, computer-aided publishing, document retrieval, and related technical applications that require extremely high performance.

Key features of the GMA201 monochrome display include 1536 lines by 2048 horizontal addressable pixels, digitally-adjusted focus, and astigmatism correction to provide a crisp, well-focused beam at all points on the screen over the entire range of gray-scale. A patented low-capacitance gun structure provides small uniform spot size and low power dissipation. A 60 Hz (75 Hz optional) noninterlaced refresh rate, high-bandwidth 200-MHz amplifier and contrast enhancement panel provide maximum image fidelity. The ruggedly constructed GMA201 complies with worldwide safety and emissions standards.

Products are designed for reliability with a premium on dependability. Tektronix features measurable value and extensive service support. Your local Tektronix OEM representative will show you how to profit from a partnership with us.

CHARACTERISTICS

DISPLAY

Addressable Area—267×356 mm (10.5×14 in).
Addressable Resolution—≤1536 lines ×2048 pixels at 60 Hz noninterlaced.
Aspect Ratio/Line—3:4 nominal.
CRT Orientation—Long axis horizontal.
Brightness—100 cd/m² (30 fL) with installed 62% contrast-enhancement filter.
Geometric Distortion—Incremental nonlinearity: ±3% at 25°C. Positional Accuracy: ±1% of image height. Peak-To-Peak Line Variation: ±5%.
Spot Size—7.5 mils (0.19 mm) center screen (maximum). 9.0 mils (0.23 mm) corners (maximum).
Focus, Astigmatism—Dynamically controlled, digitally adjusted using ROM look-up table.
Phosphor Type—WW (P4).
Compliance—UL, FCC, VDE (with Option 23).

VIDEO AMPLIFIER

Bandwidth—Dc to 200 MHz (-3 dB)
Pulse Response—T_r ≤ 1.8 ns nominal. T_f ≤ 1.8 ns nominal.

VIDEO INPUT

Interface—Linear, dc coupled.
Impedance—50 Ω.
Recommended Input Signal Rise and Fall Time—≤1 ns.
Level—Black=0 V, white=+1.0 V.
Maximum Nondestructive Input—+5 V, −2 V.

SYNC INPUTS

Interface—TTL Compatible, falling-edge triggered.
Horizontal Sync—93 kHz, ±2% standard (64 kHz or 78 kHz optional).
Vertical Sync—60 Hz standard (75 Hz optional).
Vertical Retrace Time—≤250 μs.
Horizontal Retrace Time—≤2 μs.

AC POWER

Range—87 to 128 V, 174 to 256 V; 48 to 63 Hz.
Power Consumption—150 W maximum.

CONDITION INDICATORS

Scan fail. Low-voltage power supply. High-voltage power supply.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	447	17.6
Height	389	15.3
Depth	485	19.1
Weight ≈	**kg**	**lb**
Net	25.0	55.0

ORDERING INFORMATION

GMA201 Monochrome Raster Display Monitor **$3,825**

OPTIONS

Option 23*1 —Cabinetry and CRT Bezel. **+$870**
Option 30—64 kHz Horizontal Sync. **NC**
Option 32—78 kHz Horizontal Sync. **NC**
Option 38—75 Hz Vertical Sync. **NC**

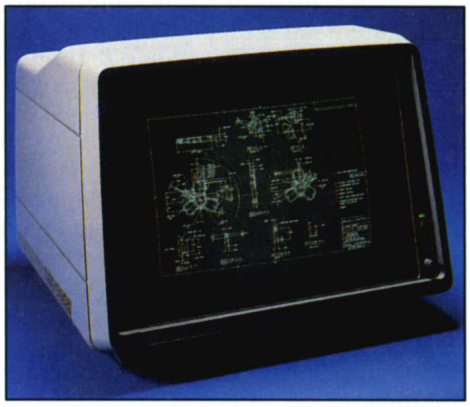
INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

*1 *Option 23 includes a standard North American 115 V power plug. Option 23 is required to order A1-A5 power plugs.*

OPTIONAL ACCESSORIES

Service manual (070-5079-00).



For further information, contact:
Tektronix, Inc.
P.O. Box 500, MS 46-539
Beaverton, Oregon 97077
or call: 503-627-6868
(800) 835-9433, ext. 6868
TWX: 910-467-8708
TLX: 151754
FAX: 503-627-2670

GMA202

19 in. Monochrome Raster Display Monitor

- **Ultra-High Addressability and Visual Resolution**
- **Maximum Picture Fidelity**
- **1536×2048 Pixels/Line**
- **Page Format**

The GMA202, is an addition to Tektronix' OEM display products, a family that provides unparalleled raster scan video performance. The GMA202 is especially suited to systems in the fields of medical imaging, military reconnaissance, architectural CAD, computer-aided publishing, document retrieval, and other similar technical applications that require gray scaling or detailed images. The high dynamic range of the GMA202 easily supports 8 bits of gray scale.

The GMA202 makes the benefits of high-resolution video available to the system builder. Key features include a bright, stable, flicker-free display with up to 1536 horizontal by 2048 vertical *viewable pixels*, and a well-focused beam at all points on the screen. A high-bandwidth 200 MHz amplifier affords maximum image fidelity while digitally-adjsted focus and astigmatism tracking provide crisp, stable displays, even in the corners. To improve viewability, a variety of contrast-enhancement filters (bonded to the CRT faceplate) are available.

The CRT for this monitor was developed at Tektronix' Component Design facility. Specifications include small uniform spot size, rugged construction, and low power dissipation. A patented low-capacitance gun structure is used to meet these specifications. The GMA202 can operate without fans or complex cooling techniques, yet provide users with a very high-resolution, reliable display at nominal cost.

CHARACTERISTICS

CRT CHARACTERISTICS

Addressable Area—267 by 356 mm (10.5×14 in).

Addressable Resolution—1536 H × 1536 V pixels @60 Hz (1536 H × 2048 V pixels available in late 1987)

Aspect Ratio—3:4 (Long axis vertical)

Spot Size (shrinking raster)—7.5 mils (0.19 mm) center screen 9.0 mils (0.23 mm) corners (maximum)

Brightness—100 cd/m² (30fL) with installed 62% contrast filter

Phosphor—WW (P4) phosphor

Focus—Dynamically controlled, digitally adjusted.

Astigmatism—Dynamically controlled, digitally adjusted.

Geometric Distortion—Incremental non-linearity: ±3% @25°C. Positional accuracy: ±1% of image height. Peak-to-peak line variation: ±5%

ELECTRICAL CHARACTERISTICS

Video Amplifier—Bandwidth: 0 to 200 MHz nominal. Pulse Response: $T_r \leq 1.8$ ns nominal. $T_f \leq 1.8$ ns nominal. Recommended input signal rise and fall time: ≤1 ns.

Video Input—Interface: Linear ac coupled, dc restored with black referenced to blank level or back porch. Impedance: 75 Ω. Level: Black=negative; White=0.7 V above black. Max non-destructive inputs: ±3 V

Sync Inputs—Interface: TTL compatible, falling edge triggered. Horizontal sync: Frequency=94 kHz (64 to 93 kHz available; 94 to 126 kHz available 4th quarter 87). Vertical sync: Frequency=50 or 60 ±3 Hz; 50 to 120 Hz interlaced or non-interlaced available). Pulse width: ≥1 μs. Vertical retrace time: ≤250 μs. Horizontal retrace time: ≤2 μs.

Power Requirements—150 watts maximum (convection cooling). Input voltage selected by voltage range switch. Range: 87 to 128 volts, 174 to 256 volts, 48 to 63 Hz.

Condition Indicators—Scan fail indicator. Low-voltage power supply indicator. High-voltage power supply indicator.

ENVIRONMENTAL CHARACTERISTICS

Shock—Nonoperating: 20 g's, ½ sine, 11 ms duration.

Vibration—Nonoperating: 15 minutes along each major axis. Displacement of 0.015 in. with frequency varied from 10 to 40 to 10 Hz.

Temperature Range—Operating: 0 to 55°C Nonoperating: −40 to +60°C.

Humidity—Operating to 95% relative humidity (non-condensing)

Altitude—Nonoperating: 15 Km (50,000 ft). Operating: 4.5 Km (15,000 ft).

Safety Certification—UL 114/478, CSA 154, IEC 380/435, DHHS 21 CFR, Subch. J, parts 1020 and 1030. UL544 information available upon request.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	498.5	19.625
Width:	355.6	14.000
Depth:	502.9	19.800
Weight ≈	**kg**	**lb**
Net	25	55

ORDERING INFORMATION

GMA202 Monochrome Raster Display Monitor **$3,825**

OPTIONS

Option 01—WB (P45) Phosphor with 30% contrast enhancement filter. **+$100**

Option B1—Includes service manual. **+$75**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz

Option A2—UK 240 V, 50 Hz

Option A3—Australian 240 V, 50 Hz

Option A4—North American 240 V, 60 Hz

Option A5—Switzerland 220 V, 50 Hz

For further information, contact:
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TWX: 910-467-8708
TLX: 151754
FAX: 503-627-2670

600
Series Monitors

- **General-Purpose, Economical X-Y Displays to Very High-Resolution X-Y and Raster Displays for Critical Applications**

606B
Monitor

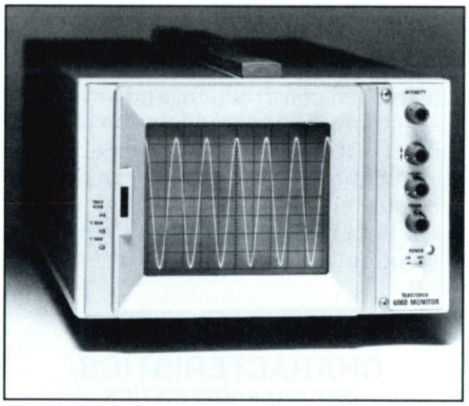
- **Very High-Resolution X-Y Display for Applications Requiring the Most Critically Sharp Photographs and Displays**

The critically sharp and detailed imaging provided by the 606B is particularly well suited for photographic recording applications in medical gamma camera systems and multi-imaging systems. It can also provide superior imaging in such applications as electron microscopy, and radiation and thermal scanning systems. When image stability, gray-scale performance, and brightness uniformity are critical to the quality of measurement or the accuracy of a medical diagnosis, you need the consistent performance and high reliability of the 606B Monitor.

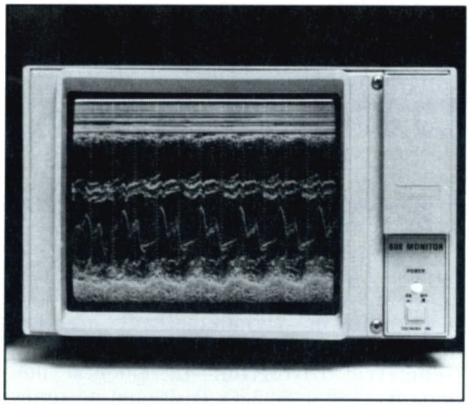
608
Monitor

- **High Resolution with Ambient-Light Viewing**
- **Expansion-Mesh-Halo Suppression**
- **Excellent Gray Scale**
- **High Brightness**

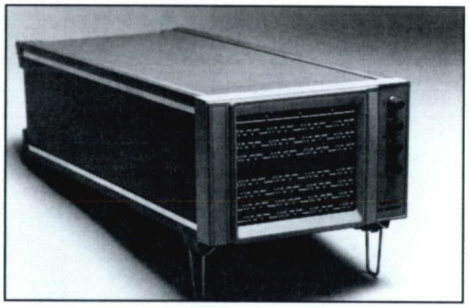
The 608 is a high-quality directed-beam viewing monitor. It is extremely well suited for high-peformance display applications, such as medical and military imaging and electronic instrumentation. The 608's high usable brightness of up to 240 cd/m² (70 fL), 0.26 mm (10-mil) spot size, and a large 9.8×12.2 cm screen all combine to give you optimum viewing capability. The 608 produces detailed displays that are easy to read in high ambient light. The crisp high-brightness image also yields high-quality photographs when an appropriate camera is utilized.



606 Option 06



608 Option 23



620 Option 23

620
Monitor

- **General-Purpose, Economical, X-Y Waveform Display**

The 620 can be used in demanding applications requiring an economical, solidly performing X-Y waveform display. Electronic instrumentation applications include pulse height, network, spectrum, logic and signal analyzers, and digitizers. The 620 can also be used in mechanical measurement instruments for vibration tests and NDT. In the medical field it can be used for A-mode imaging. The 620 offers a spot size of 0.38 mm (15 mils), a 10×12 cm screen, and usable brightness up to 100 cd/m² (30 fL).

KEY SPECIFICATIONS FOR X-Y DISPLAYS

	606B	608	620
Spot Size*1	0.08 mm (3.1 mils)	0.26 mm (10 mils)	<15 mil <25 mil at max drive
Display Size	8×10 cm	9.8×12.2 cm	10×12 cm
Acceleration Potential	5.5 kV	22.5 kV	12.0 kV
Bandwidth, X-Y*2	>3 MHz	≥5 MHz	≥2 MHz
Bandwidth, Z*2	5 MHz	≥10 MHz	≥5 MHz
Rise Time	<35 ns	≤35 ns	
Input R and C, X-Y*3	1 MΩ ±1% or 50Ω <47 pF	1 MΩ≤ ≤60 pF	1 MΩ< ≤47 pF
Input R and C, Z*3	1 M or 5 MΩ	1 MΩ ≤60 pF	1 MΩ, <47 pF
X-Y Phase Difference	1° to ≥ 500 kHz	≤1° to 1.5 MHz	≤1° dc to 500 kHz
Recommended Source Impedance, X Y and Z	<10 kΩ in 1MΩ pos.	≤10 kΩ	≤10 kΩ
Temperature Range	0 to 50° C	0 to +50° C	0 to +50° C
Power Requirements*4	75 W	61 W	See footnote*4
Included Accessories		Lined external implosion shield (graticule) for adjustment purposes.	Lined external implosion shield (graticule) for adjustment purposes
Recommended Cameras	C-30BP, C-5C Opt.01, C-7 Opt. 01	C-5C Opt. 01, C-7 Opt. 01 C-59A	C-5C, C5-C Opt 01 C-7 Opt. 01

*1 *Measured at 0.5 μA, except for the 606A, measured at 0.1 μA.*
*2 *Full spec would read: 'dc to . . ." appropriate figure.*
*3 *"<" means "paralleled by less than".*
*4 *Line-voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V (±10• on each range). 48 to 440 Hz (except the 624 which excludes 220 V). Number given shows watt max at nominal line voltage. The 620's power requirements are 90 to 132 V ac; 48 to 440 Hz, 22 W max, 0.2 A at 120 V ac, 60 Hz.*

634/634LC

Monitors

High-Resolution Video Display for Critical Applications (1400 Lines, Shrinking Raster)

The 634 raster-scan monitor delivers extremely high quality video images for both viewing and photography. Applications include medical diagnostic imaging, military infrared imaging, and automated test systems. The 634 has been specifically designed to deliver the superior performance required to meet those demands.

The 634LC offers an economical version of the raster-can 634. The power supply and user controls have been deleted. The user needs to furnish dc input power (+23, −22, +9 V unregulated). All controls are accessible via pin connectors at the rear of the monitor.

For further information, contact:
Tektronix, Inc.
P.O. Box 500, MS 46-539
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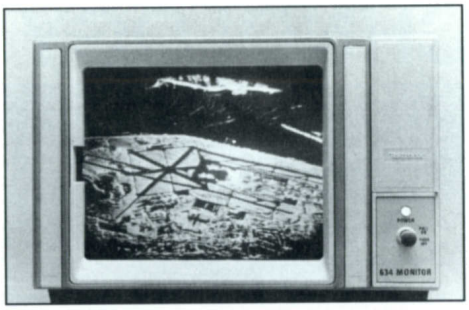
TWX: 910-467-8708
TLX: 151754
FAX: 503-627-2670



ORDERING INFORMATION

606B Monitor*1	$4,925
608 Monitor*1	$3,080
620 Monitor*1	$1,710
634 Monitor*1	$3,610
634LC Monitor*1	$2,510

Recommended Cameras—
C-5C Option 01, C-7 Option 01, C-59A.

*1 *Without handle feet or covers.*

KEY SPECIFICATIONS

Video Display	**634*1 634LC**	**634 Option 01 634LC Option 01**
Display Size (flat screen)	9 cm×12 cm	9×12 cm
Resolution* 1 At least	1100 line	650 line
Position Accuracy/Nonlinearity	≤0.5% within 9 cm circle. ≤1% in corners. For Option 01: 1% within 90 mm circle, 2% at corners	
Brightness	515 cd/m² (150 fL) max	
Brightness, Nonuniformity	Less than ±10%	
Bandwidth	1-10 Hz std. (20 MHz video bandwidth available as Option 14.)	

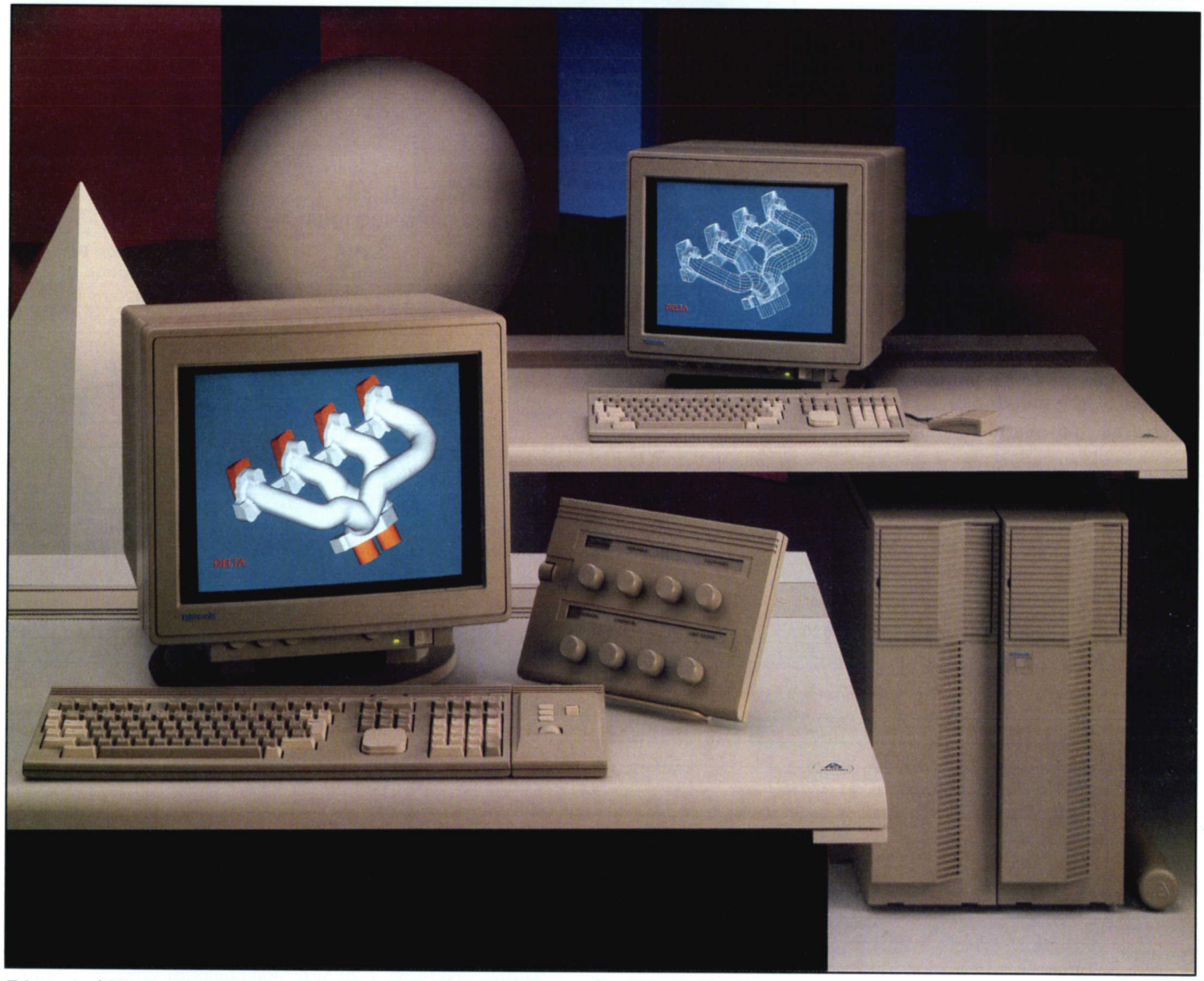
*1 *Merged raster lines.*
*2 *Standard 634 accepts the line/field rate of 625/50. Discrete line rates of 675/60 through 1083/60 can be accommodated using Option 15. Option 15 is factory calibrated at 1029/60.*

	606B	608	620	634	634LC	Description	Price
Option 01		✓	✓			Internal Graticule	NC
Option 01				✓		Resolution of 800 Line Nominal, 650 Worst Case	−$150
Option 01					✓	Resolution of 800 Line Nominal, 650 Worst Case	−$155
Option 06			✓			UL 544 (Includes Handles, Feet and Covers)	+$100
Option 06				✓		UL 544 (Includes Handles, Feet and Covers)	+$105
Option 06	✓					UL 544 (Includes Handles, Feet and Covers)	+$125
Option 07	✓					Screwdriver Front Panel Controls	+$30
Option 09	✓	✓	✓	✓		UL 544 Component Recognized	NC
Option 10		✓	✓			25-Pin Remote Program Connector	+$55
Option 12		✓	✓			GM (P7) Phosphor with Internal Graticule	+$65
Option 13				✓		Reverse Video	+$85
Option 14				✓		20 MHz Video Amplifier	+$145
Option 15				✓		Variable Line Rates	+$280
Option 15					✓	Variable Line Rates + 20 MHz Video Amplifier	+$600
Option 16				✓		25-Pin Video Input	+$55
Option 20			✓ (6,31)* 1			AC Delete	−$20
Option 21		✓				Full Differential Inputs	+$60
Option 22		✓				Extended Gain Range	+$45
Option 23		✓ (28)* 1	✓ (6,28,31)* 1			Handle, Feet and Covers	+$110
Option 24		✓				Linearized Z-axis	+$75
Option 25		✓				TTL Blanking	+$75
Option 25			✓			TTL Blanking	+$50
Option 28	✓ (6)* 1	✓ (23)* 1	✓ (6,23,31)* 1			Covers Only	+$90
Option 29		✓				Metal Bezel	+$70
Option 31			✓			Delete all Rear BNC's, DC Power Connector and AC Power Supply and Switch	−$25
Option 76		✓	✓			GM (P7) Phosphor	+$65

* 1 *Not available with these options.*

Special pricing terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.

DISPLAY TECHNOLOGY



Tektronix 4330 Graphics Workstations provide 3D shaded surface and wireframe modeling systems.

TEK MEANS . . . GETTING THE PICTURE

with color enhancement, the power of intelligence, system integration, software, and more . . .

Display Technology—An Integral Part of Our Business

For over forty years, Tektronix has designed and manufactured advanced electronic products, starting with cathode-ray oscilloscopes. Our innovative design efforts developed features such as the flat-faced CRT, the direct-view storage tube (DVST), the high-resolution liquid-crystal-shutter display, and the microchannel-plate CRT. The latter is incorporated in our 7104 "Gigahertz" oscilloscope, which remains unapproached in bandwidth and performance after six years in the marketplace, and in the 11302, R7103, and 2467 oscilloscopes.

We're the Leader

We placed affordable graphics in the hands of engineers and scientists in 1971, using our experience in DVST design (in lieu of the then high cost of computer memory). Our PLOT 10® software early on became the *de facto* standard. Today, Tek PLOT 10 is installed on more computers than any other graphics utility library in the world. Our up-to-date graphics line covers a broad spectrum of needs.

Color aids in differentiating dense graphics. Displays with default color tables (and color interfaces to modify colors to your specific application) eliminate viewability problems. Our Imaging Research Lab is developing standards based on human perception and reaction to color.

Meeting Expanding Customer Needs

Our products are developed to fill your needs. Tek continues as an industry leader for product-line breadth, range of price/performance options, and service support. Tek innovation, reliability, and flexibility are built into all our products, which continue to set standards around the world.

Our Products Have a Lot to Display

Computer graphics is no longer constrained to simply drawing pictures or plotting data, but is emerging as an effective, efficient human interface to computers.

The high-quality graphics capabilities that were made available to an extensive line of host-based graphics terminals are now available in our powerful intelligent workstations. Tedious manual digitization of engineering drawings is eliminated with a Tek graphics input workstation. Also, Tek color copiers produce hard copy with resolutions that exceed terminal resolution. Our expanded artificial-intelligence family increases productivity in many areas of research and development, including expert systems, natural languages, and automatic programming. Our color terminals enhance operation in a number of areas, such as single-keystroke access to the powerful TNIX operating system and Tek's microcomputer design tools where soft keys simplify command entry and minimize keystrokes. A choice of color terminals is also offered for our acquisition/processing measurement systems. Some of our newest spectrum analyzers even provide a CRT display of operator "helps," in a choice of plain English, plus optional French, German, or Spanish. This year, again, we have a lot to display.

Color Perception

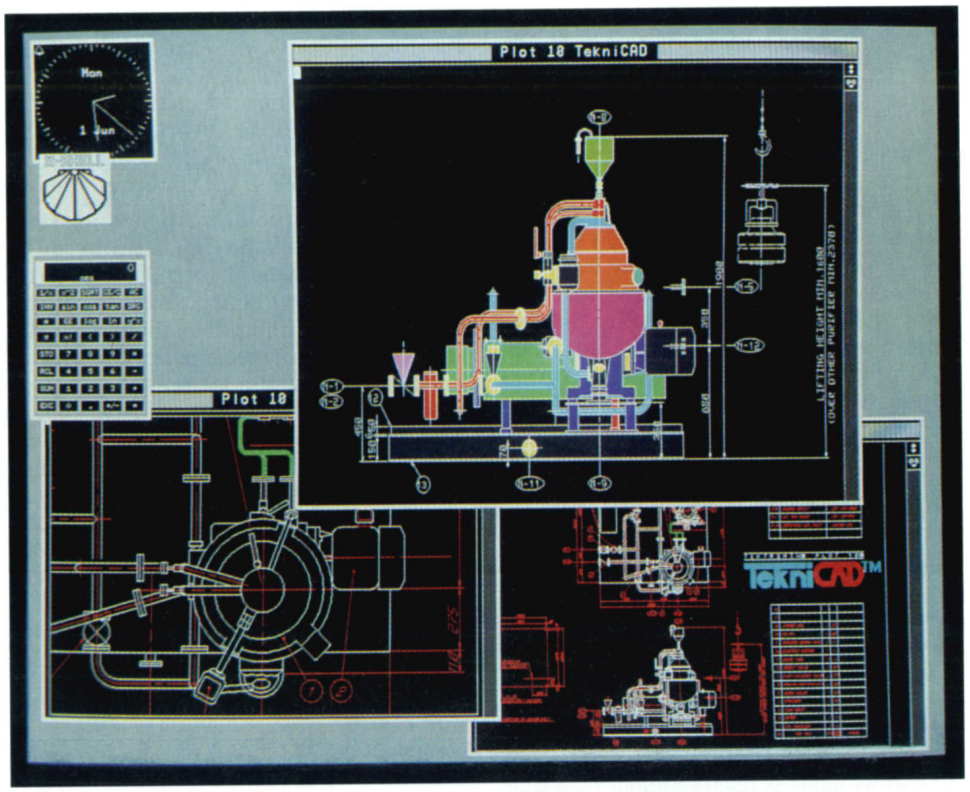
The physiological fact behind color's continued success in displays is that the brain has two separate channels for processing visual information: one chromatic, the other achromatic. In many instances, data from both processing channels is used to interpret an image. An achromatic display deprives the operator of one entire visual data channel. Without this chromatic data flow, the brain's processing power is reduced, especially when interpreting complex visual information. The use of color substantially improves the readability of electronic-instrument displays.

Color is particularly beneficial when viewing a complex display with high information density.

First, color can be used to organize information into logical groupings. High-priority items can be coded one color, and low-priority items another.

Second, color can be used to locate information. This technique is especially useful when small but important items might be visually lost in a mass of other information.

Third, color can attract attention. Finding a single element in a complex array is easy when a color difference exists. A specific color can be associated with a particular class of events, such as red for warning or yellow for critical information. Color also allows a single instrument to function in different modes with a particular color unambiguously signaling the mode.



Tektronix PLOT 10® TekniCAD™.

Fourth, color definitely has a high aesthetic appeal that reduces the monotony of prolonged display viewing. Although only subjective reports substantiate this aspect, color appears to enhance productivity by reducing boredom and fatigue.

Ergonomics of Color

Through technical improvements and cost reductions, color has now become a potentially powerful tool for improving the instrument/user interface. Yet, the misuse of color can make the interface more difficult instead of easier. Not all systems benefit from color.

Color is a product of human perception, the result of the eye reacting to "visible" wavelengths of electromagnetic radiation. The optical and sensory mechanics of the eye give color its three basic qualities:

Hue, which identifies the color in relation to other colors in the spectrum, such as red, yellow, green, etc.

Saturation, which defines the "purity" of color. As spectral colors become less pure, they appear more gray or white.

Lightness, which refers to the relative strength of the light coming from the color, as perceived by the observer.

As the wavelengths of visible light change, the eye perceives a changing hue that produces the familiar spectral colors, ranging from deep red through yellow, green, and blue to purple. At any given wavelength, a "pure" color is produced that yields maximum saturation. Pure colors can be desaturated by increasing lightness until the color is "washed out."

Color distribution and saturation play an important part in color perception. Colors widely separated in the spectrum, such as red and green, are much easier to discriminate than neighboring colors. Also, "grayish" colors of low saturation become difficult to separate. On the other hand, highly saturated colors that are also widely separated in hue require the eye to refocus, which can be a source of fatigue. Another important consideration is that the eye's foveal region, which yields maximum visual resolution, is essentially "blind" to the color blue, making blue a poor choice for presenting detailed information.

PLOT 10 is a registered trademark of Tektronix, Inc. TekniCAD is a trademark of Tektronix, Inc.

Color Display Technology

The CRT is the most important factor in determining the characteristics of a color display. Tektronix color-display technology produces three basic types of CRTs: the shadow-mask CRT, the liquid-crystal (LC) CRT System, and the direct view storage tube (DVST) with color write through (CWT). The choice of CRT and display system is determined by the user's needs and application. For any particular color-display application, the user is concerned with image quality and information-handling capability relative to that application.

SHADOW-MASK CRT

The shadow-mask CRT is the most commonly used type of CRT for color displays. In fact, the shadow-mask CRT is the type used for home television and for television-studio picture monitors. Usually, three electron guns are used to address three primary color phosphor dots or stripes. The dots are spaced close enough so they appear as one. Colors other than the three primary colors result from proportional mixtures of the individual dots. A shadow mask is used to make sure that each beam addresses only its assigned color dot. The beams from the red, green, and blue guns must pass through the mask openings at the proper angles to strike their corresponding phosphor dots.

The three beams are deflected together over the phosphor screen in a raster pattern.

High-Resolution Displays

One of the most important factors in the recent evolution of computer graphics has been the emergence of high-resolution, low-cost raster displays. We've overcome the problem of CRT flicker with 60-Hz noninterlaced monitors. Raster technology is pushing the limits of human perception.

In other systems (e.g., home television), an interlaced raster is used. An interlaced display scans every other line in the first pass from top to bottom, then returns to the top and scans the intermediate lines in the next pass. A color image is drawn on the screen by the display system, which determines when each of the three electron guns receives current, and how much, and thereby how much of each color is produced at each point (pixel) on the screen.

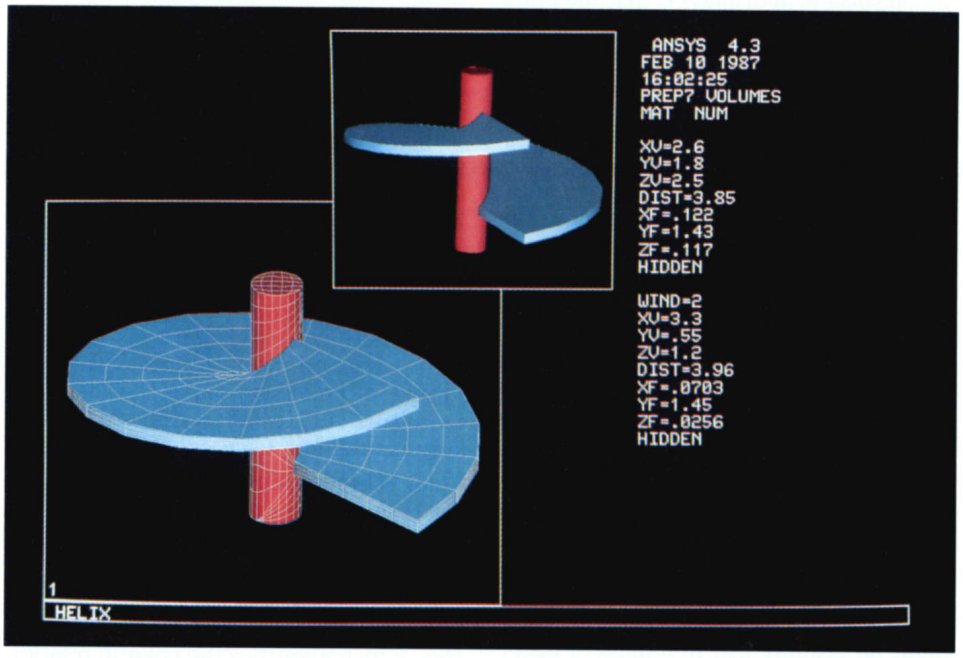
When a shadow-mask CRT is used in graphics applications, a bit-map memory is used to store the image. The pixel information from the bit map is read out to the three electron guns synchronized with the raster pattern of the beams. To produce an image on the CRT screen, the desired vectors and other shapes must first be converted into the proper pixels in the bit map using a scan-conversion process. Algorithms are used to code the various shapes into several digital bits, which represent the brightness desired at each pixel location on the screen.

Information in the bit map must be read out repeatedly to the CRT at a rate sufficiently fast to avoid flicker. Therefore, the time required to change images on the screen is determined by how fast the scan-conversion process can reload the bit map. The larger the bit map, the slower the reloading process; thus, raster images with a large number of pixels must trade off speed of interaction. As the number of pixels increases, so does the rate at which information is clocked out of the bit map. The deflection speed of the CRT beam and the bandwidth of the CRT video amplifier must increase accordingly. Deflection speed and video amplifier bandwidth ultimately limit the number of pixels possible.

LIQUID-CRYSTAL COLOR DISPLAY

A method of producing color displays without shadow masks, color-dot phosphors, or any of the other usual techniques has been developed by Tektronix. Based on a combination of liquid-crystal and cathode-ray-tube technologies, this LC/CRT system combines a black and white or "monochrome" CRT and a liquid-crystal "color shutter" to produce a very-high-resolution, field-sequential color display. Functioning as a color shutter, this very fast switching device fits in front of the CRT face, thus making it practical to build high-resolution color displays into oscilloscopes and other display instruments. Because no shadow mask or patterned phosphors are used, the resolution can be as high as any monochrome CRT. This feature is a particular advantage in small display sizes where high-resolution color has not been practical before.

The "monochrome" CRT employed has a simple phosphor with two separate emission peaks in the orange and blue-green areas. The phosphor does not require any special process steps. However, the true "state-of-the-art" advance represented by the color shutter is the liquid-crystal shutter itself, which provides a three-color display (orange, blue-green, and neutral) of excellent crispness, detail, and color purity. On the 1241 Logic Analyzer, the LC shutter is basically a sandwich consisting of a color polarizer, a variable-retardation liquid-crystal cell, and a linear polarizer. The LC shutter consists of two glass plates coated with indium tin oxide for the transparent conductor, a thin layer of silicon dioxide for an insulator, and a special "alignment" layer that causes the director (essentially the major axis of the liquid crystal) to tilt in the same direction on both surfaces.



High-resolution graphics to fit today's and tomorrow's needs. The Tektronix 4330 3D Graphics Workstations offer capabilities from 2D and 3D wireframe to 3D shaded surfaces. Swanson Ansys software is used here.

Field-Sequential System

Previous efforts to produce a field-sequential system have suffered from the lack of a suitably fast color shutter. Earlier attempts at fabricating LC color shutters have used simple twisted nematic (liquid crystal) devices or dual-frequency nematic devices. The simple LC devices generally have relaxation times (essentially the time to switch from one polarization state to another) that are much longer than several milliseconds and are not suitable for fast switching applications. Flicker-free operation of a sequential two-primary-color display requires field rates of 120 Hz, for example, which in turn requires LC shutters capable of millisecond transition times for both the on and off states. Dual-frequency devices can have sufficiently fast response but require the use of drivers that must deliver a high-frequency signal into a large capacitive load.

Employing a field-sequential system with displays having cells switched at a single frequency overcomes the need for high-voltage switching, a drawback of the dual-frequency cell approach. Typical dual-frequency cells are turned on with a low-frequency burst and turned off with a high-frequency signal, while the variable retardation cell's elements are controlled by a single frequency. As a result, the driving waveforms are simpler and the driver's power requirements are less.

In any one field, the information written on the screen appears only in the color selected by the LC shutter. The field-sequential system can provide all possible mixtures of the two primary colors contained in the phosphor. Each color or information field is displayed at a 60-Hz repetition rate.

The PI Cell

The variable-retardation cell (called a pi cell) is sandwiched between a set of red and green color polarizers and a linear polarizer at the output. The latter's axis is tilted 45° with respect to the polarizers. The color polarizer orthogonally polarizes the orange and blue-green components of the CRT's emission, and the pi cell is used to sequentially rotate the polarized orange and blue-green information into the transmission axis of the linear polarizer. Rotation of the orange and blue-green information is performed in synchronization with the fields of the sequentially addressed CRT. Alternate fields, viewed through different color polarizing filters, are integrated by the eye to give color images. By varying the z-axis modulation, the full range of colors that lie along the line connecting the orange and blue-green peaks of the phosphor's emission spectrum on the chromaticity diagram can be achieved.

The pi cell derives its name from the pi-radian amount of twist it assumes in its quiescent, or undriven-state. Its features are achieved by speeding the relaxation time of an already fast untwisted birefringent variable-retardation cell, whose liquid-crystal elements are homogeneously aligned.

It is advantageous to keep the cell as thin as possible to provide a large angle of view, but narrowing the cell too much prevents achievement of the full half-wave retardation that is required. For LC shutters, such as used in our 5116 Oscilloscope and the 1241 Logic Analyzer, there is no perceptible color shift over the normal viewing angle.

High Resolution, High Contrast

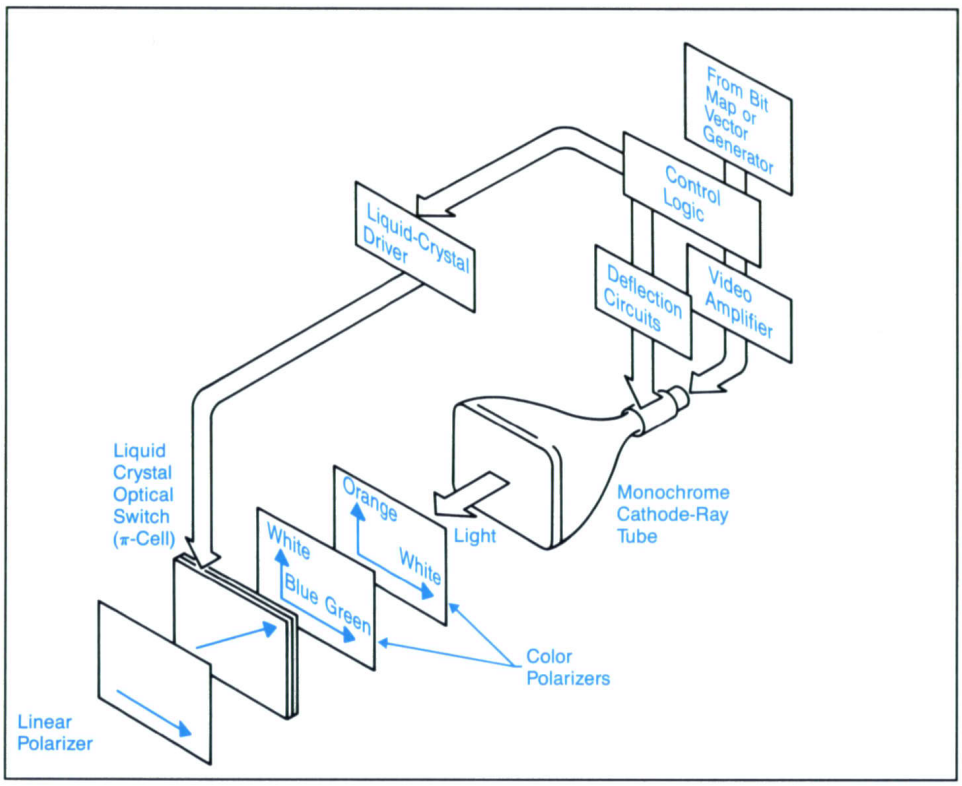
Among the LC/CRT system's advantages are high resolution over a wider range of display sizes, good contrast in high ambient light, and ruggedness, due to the absence of special shadow-mask and phosphor arrangements or complex electron guns. The LC color shutter can be used in either vector or raster displays. The combination of the color shutter and either a diffusing or an antireflection coated front surface can yield contrast ratios of better than 20:1 in the high ambient lighting normally found in today's offices. Since all screen writing is accomplished by a single electron beam, rather than by three beams as in a shadow-mask display, the LC shutter does not have misconvergence problems. This feature enhances resolution and produces a very readable display of text and complex graphics.

COLOR-DISPLAY CHARACTERISTICS

Image quality and information-handling capability are the two broad categories of characteristics that are important to users of color displays. Image quality includes optical characteristics like resolution, edge sharpness, brightness, contrast, and color quality. Environmental "noise" can cause undesirable optical characteristics of displays such as flicker, jaggies, and moiré patterns. Information handling capability includes characteristics like display size, number of vectors or pixels, and number of colors.

Resolution

The quality of the image is strongly affected by the resolution of the display system. However, the term resolution is often used synonomously with the number of scan lines (addressability) in discussions of raster displays. Resolution refers to the display's ability to resolve or separate two closely spaced points, lines, or spatial frequencies. Resolution is the essential characteristic that determines image sharpness.



Field-sequential system.

The resolution of a display comprises a combination of elements including spot size, spot profile, dot spacing, number of scan lines, and bandwidth. Addressability, on the other hand, refers to the display's ability to position lines or pixels anywhere on the screen. A display may have addressability that exceeds its resolution capability and so will not affect the resolution of the display. However, if the addressability is not high enough, it will affect the resolution of the display in complex images.

COLOR-QUALITY CHARACTERISTICS

Quality of color includes brightness, contrast, purity, and convergence.

Contrast

Both the DVST with CWT and the shadow-mask types of color displays reflect and scatter about the same amount of room light, so display contrast is determined by trace brightness. Display contrast can be improved by placing a filter in front of the display screen that will attenuate the emitted light less than the reflected light, which must make a double pass through the filter. Selective filters are also used to absorb room light while transmitting the emitted light from the display. Antiglare screens, which have either a special coating on the front surface or a matte finish to prevent specular reflections, are also used to improve display contrast.

Color Purity and Convergence

Color purity generally refers to the uniformity that a color has over a large area of the display screen. Purity is a measure of whether or not the primary colors selected by the individual beams are spectrally pure. If some electrons meant for the red dot impinge upon the green dot, then the primary color is not pure. Purity is not really much of a problem in shadow-mask CRT displays. Each of the three beams should excite the entire phosphor dot when the beams pass through the shadow-mask holes properly.

High-resolution displays introduced another new problem: *misconvergence.* When the display is not properly converged, a line written as yellow, for example, comes up with a red and green fringe on either side. Misconvergence, which was simply annoying on the previous new generation of high-resolution displays, has become a source of potential misinformation on the new generation of high-resolution displays. In fact, the convergence specification over the entire active area of the display becomes the effective resolution limit. That is, a 1000- line display is not usable as such unless the convergence specification ensures no detectable misconvergence anywhere on the screen.

INFORMATION-HANDLING CHARACTERISTICS

Size

The ultimate size of color displays using DVSTs and shadow-mask CRTs is about 636 mm (25 inches) diagonally. The DVST can also be made quite small (152 mm or 6 inches) and still provide a large number of vectors because the spot size can be scaled down accordingly. The number of vectors in the color-refresh mode is not limited by the resolution, but by the deflection speed required to write the vectors at a flicker-free rate. To display a large number of vectors, the deflection system must have a very high bandwidth, usually at the expense of power. However, the DVST avoids the need for high power with large numbers of stored vectors, though it faces the same trade-off for the refreshed color vectors.

Number of Colors

The DVST with CWT has a maximum of three colors. Only the shadow-mask CRT offers a full range of colors. The color capabilities of a shadow-mask CRT are usually determined by the choice of phosphors for the three primary colors.

The DVST with CWT is very useful where complex images are to be displayed and color is needed only to highlight areas of the display. The shadow-mask raster display is by far the most prevalent type of color display in use today.

An attractive feature of a color terminal is its ability to display images in the desired colors. But how does one go about selecting a specific color and describing it to a terminal in meaningful, precise terms? Interactively, the user specifies a color and the terminal displays it. The user evaluates the displayed color and corrects it if necessary.

FIELD-SEQUENTIAL STEREOSCOPIC DISPLAY

The Tek LCSS-based 3-D display is a field-sequential system. A field-sequential display alternately presents the right- then the left-eye view. A single graphics system and a single video monitor can be used. A complete stereoscopic picture, or frame, comprises two fields. During field 1, the right-eye view is displayed, followed by the left-eye view during field 2. Each view is stored in its own buffer and alternately displayed by the graphics system.

Since at low frame rates, for example 30 Hz, image flicker can be quite noticeable, the frame rate, or refresh rate, is one figure of merit for field-sequential stereoscopic displays. For computer-generated images, especially those with high spatial frequencies (such as wire-frame images with single-pixel-wide elements), a frame rate of 60 Hz or more may be necessary to eliminate flicker.

A way to alternately prevent each eye from seeing the other eye's view is essential in all field-sequential stereoscopic systems. This can be accomplished by a pair of shutters, one for each eye. One prevents the left eye from viewing the monitor while the image for the right eye is being displayed, and vice versa. Both mechanical and electro-optical shutters have been in use for several years. Stereoscopic displays that place the switching elements at the user are called active systems. The large-screen capability developed at Tektronix for color shutters has allowed us to construct the first passive field-sequential stereoscopic systems. A single LC switch is fitted to the CRT screen, and the user wears a pair of special "sunglasses."

The Liquid-Crystal Stereoscopic Switch

The liquid-crystal stereoscopic switch (LCSS) incorporated as an option to the NEW 4330/4230 is an electro-optical switch. The system consists of two pieces. One, the liquid-crystal shutter module (see figure), mounts on the front of the video display. Timed by a synchronization signal provided by the graphics hardware, the shutter encodes each of the eye-view images by circularly polarizing the light—left circular for the left eye and right circular for the right eye. The second part of the system is essentially a pair of polarized sunglasses modified to decode the correct view for each eye.

A field-sequential stereoscopic system has two advantages: (1) Just one graphics system and one video monitor are needed. (2) The horizontal resolution of a full screen is available for each eye view.

To these advantages, Tek's LCSS adds four advantages of its own: (1) The shutter has no moving parts. (2) The expensive piece, the shutter itself, is safely out of the user's hands. (3) All that's required for several users to view a system are individual pairs of inexpensive glasses. (4) Since the glasses are circularly polarized, users can do other work away from the display while wearing the glasses.

In the LCSS system, light transmission is good enough to be useful in typical graphics work environments. When several LCSS 3-D systems are in use in a work area, any viewer can glance from display to display. No resynchronizing of glasses is necessary. This and the preceding advantages make Tek's LCSS system a convenient and clear way to present data and structures in three dimensions.

Applications for Stereoscopic Displays

A good three-dimensional display can enhance the user's ability to see the relationships of things in a workspace, or to readily comprehend Z-axis-coded information in plots and tables.

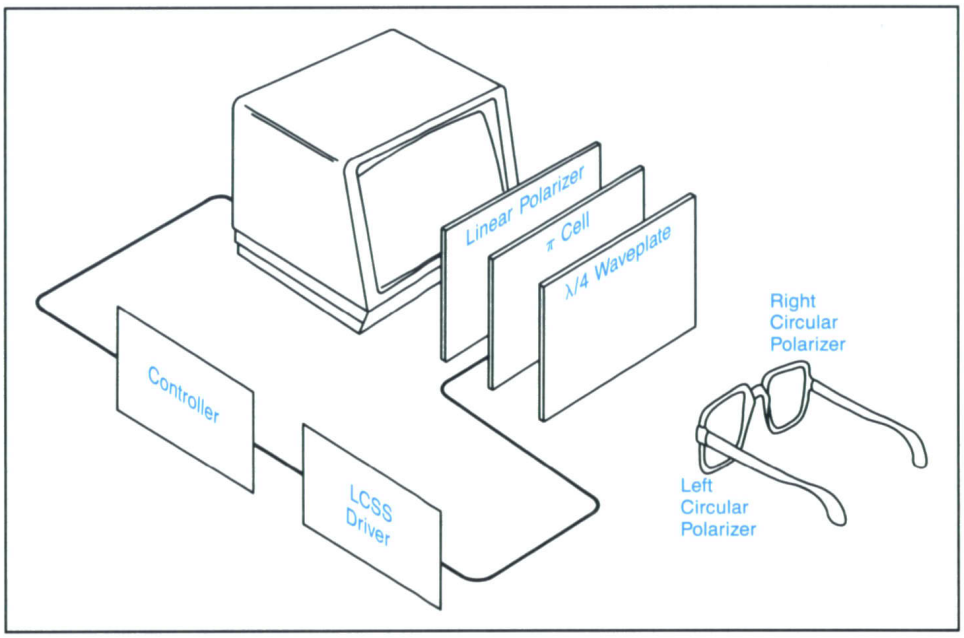
By far the most prevalent use for 3-D is as a better user-interface to a three-dimensional workspace. Traditional uses—for example in underwater salvage or remote handling of materials—stress 3-D's power to increase an operator's ability to distinguish positions in the operating environment. Many engineering tasks have similar elements, for example, specifying mesh points on an irregular surface or observing simulated tool paths.

Since the stereoscopic display improves the user's understanding of a three-dimensional workspace, it can often replace the physical model. Architects can present options to clients quickly and easily without actually constructing models. In automobile design, 3-D may replace the expensive clay models currently used.

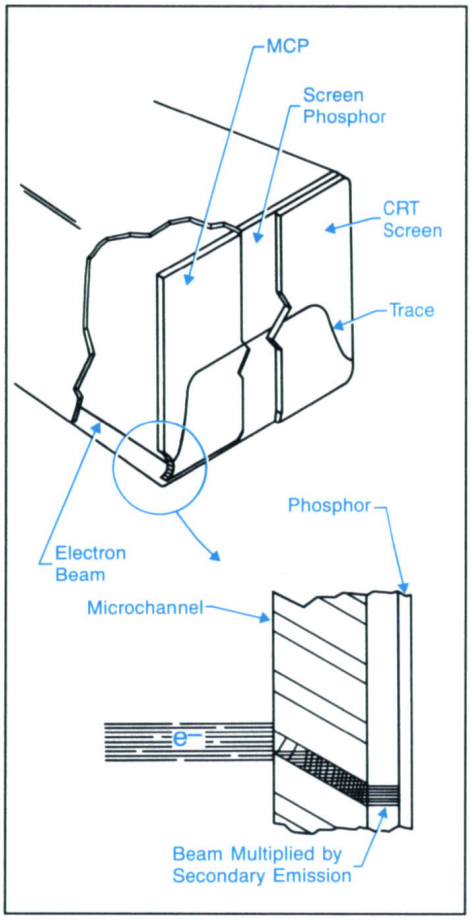
In medicine, the volumes of three-dimensional data generated by scanners are often difficult to interpret. Through computer processing and a stereoscopic display, medical researchers can derive and present clear summaries of complex data. In planning reconstructive surgery, for example, interactive, three-dimensional computer graphics can help the surgeon plan the best way to go about a cosmetically sensistive repair.

BRINGING INVISIBLE SIGNALS TO LIGHT

The 7104 and R7103 Oscilloscopes pioneered Tek's exclusive microchannel-plate CRT technology to provide the highest writing rate available today. With the 7104/R7103, any transient signal within the 1-GHz bandwidth can be seen directly on the CRT in average room light. This trace brightness is about 1000 times that of conventional oscilloscopes.



Liquid-crystal, field-sequential stereoscopic display. To view a Tek LCSS display system, the user wears glasses that are much like polarized sunglasses. Unlike user-worn devices in other field-sequential systems, these glasses do not restrict head movement or position. The viewer, wearing these glasses, can look elsewhere without restriction. Users are not tethered or harnessed to the 3-D system.



Microchannel-plate (MCP) CRT configuration.

The same technology is also available in the 2467, a portable 350-MHz oscilloscope, and in the 11302 programmable, 500-MHz oscilloscope. With a visual writing rate of 4 div/ns, the 2467 is unmatched among portable scopes. The ability to see unexpected transients, even when masked by repetitive events, makes the critical difference in many troubleshooting situations.

The Microchannel-Plate CRT

An oscilloscope CRT based on microchannel-plate technology is quite similar to a conventional CRT; the major difference is the microchannel-plate (MCP) located just behind the CRT phosphor screen. The accompanying drawing shows details of an MCP CRT.

The MCP uses a 0.050-inch glass plate having multiple, closely spaced holes located directly behind the standard phosphor screen. These holes are offset from the beam axis at a 15° angle and are internally treated to promote the generation of secondary-emission electrons. When the electron beam scans across the MCP, electrons enter the holes and strike the treated sides. This action causes secondary emission as the beam moves down the channel. The amplified electron exits the channel and travels the short distance to produce a trace on the phosphor screen.

Because of the channel multiplication of beam electrons, trace brightness is increased, even for extremely fast traces that would otherwise not be visible on the CRT. Individual channels of the MCP saturate in regions of high trace intensity, while maintaining full gain for less-intense portions. This feature, called "adaptive" intensity, tends to normalize overall trace intensity between high-and low-repetition-rate signals. Bright traces are limited to a safe viewing level, while the intensity of dim traces is increased for good visibility.

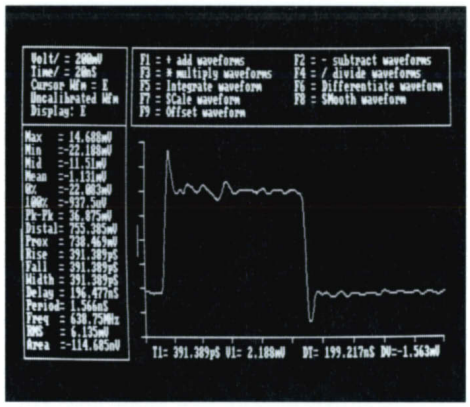
THE WORLD'S FASTEST SCOPE CAMERA

The DCS Digital Camera System combines CCD (Charge-Coupled Device) technology with advances in signal-processing hardware and software to bridge the gap between fast oscilloscopes, such as the Tek 7104 and 2467, and processing and analysis tools, like the personal computer (PC).

When used with the Tek 7104 microchannel-plate CRT oscilloscope, or the R7103, the DCS can acquire and digitize transient (nonrepetitive) waveforms at an effective sampling rate of 250 gigasamples per second, or 4 ps per sample.

The light from the scope's screen phosphor is optically coupled to the camera, which captures it on a photosensitive CCD scan-conversion target. This 490×384-pixel image is transferred out of the camera at a video rate for conversion by a Frame/Store board slotted in the PC. Because the waveform image is optically coupled into the CCD scan converter—essentially parallel optical sampling—the major bandwidth limit is the scope itself. On the PC, menu-driven software allows easy manipulation of the waveform for display, signal processing and analysis, hard-copy output, magnetic storage, or porting to a mainframe via RS-232C or the GPIB.

DCS hardware and software work together to provide exceptional resolution and accuracy. Resolution is derived from three dimensions—a significant advance



Waveform captured by digitizing Camera System and displayed on PC monitor.

over traditional two-dimensional, or X-Y, acquisition. The third dimension, the Z axis, measures trace intensity to 8-bit resolution. When combined with the 9-bit vertical and horizontal resolution, the overall nominal resolution of the DCS is 12 bits. This resolution exceeds the resolving power of the unaided human eye by at least 10 times. The Z axis provides exact data as to the center of the trace to a degree never before possible, which facilitates the averaging of noisy signals.

Waveforms can be displayed on the PC together with parametric measurements in another window. Cursors can be set along the waveform for extensive automatic waveform measurements. The camera can also be zoomed in between cursors for more detailed waveform viewing. The photo shows a fast square wave that was captured and digitized by the DCS from a transient waveform displayed on a 7104 oscilloscope. Notice the measurement information provided along with the display and the function-key menu for further operations.

For documenting results, the PC screen can be copied to a dot-matrix printer, or direct copies of video frames or of the PC screen can be made on Tektronix video copiers.

INFORMATION DISPLAY PRODUCTS

CONTENTS

PC Graphics 51
PC Coprocessor Board 51
PC Terminal Emulation Software . . 52
PC Color Graphics Monitor 52
Color Graphics Terminals 53
Graphics Workstations and Terminals 57
3D/2D Graphics Workstations and Terminals 59
2D Graphics Workstations and Terminals 62
Applications Processor 65
Entry-Level Graphics Workstations 67
Artificial Intelligence Systems 69
Applications Software and Standard Tools 71
Color Output Systems 73
Color Printers and Systems 74
Graphics Rasterizer 75
Graphics Tablets 77
Graphic Input Workstation 77
Computer Graphics Supplies 78

Tektronix has been an industry leader in information display products since it introduced the age of low cost graphics displays with the discovery of the direct-view, bistable storage tube (DVST or Anderson Tube) in 1962. Today, the breadth of the Tektronix product line, its family compatibility, peripheral support, leadership in meeting industry standards, and range of price/performance options, make Tek information display products the best-equipped to meet research, engineering, business and manufacturing needs.

Tektronix has designed its information display products to offer a wide range of price/performance. Customers can select from a variety of entry-level and high-performance graphics workstations, color terminals, and color output systems. All information display products, at all price/performance levels, provide Tektronix-quality display and power.

Tek's new products in 1988 are designed to increase selection and choice so that customers can get just the power and performance they need. Product adaptability and access to applications are broadened with IBM and DEC compatibility with most information display products. Together, Tek's current and new information display products meet the need for performance, targeted application and increased economy in graphics products.

INFORMATION DISPLAY PRODUCTS

Graphics for PC Users

The new PC4100 Graphics System offers a graphics coprocessor board, Tek terminal emulation software, and color monitor to bring the world of Tektronix graphics to IBM PC users.

Color Graphics Terminals

The 4200 Series of Color Graphics Terminals expands its versatile offering, bringing users local-intelligence graphics with the NEW 4209 Intelligent Color Graphics Terminal. And the NEW SF4208 Industrial Color Graphics Terminal delivers Tektronix graphics capability right to the manufacturing floor.

3D/2D Color Graphics Workstations and Terminals

NEW Families of 3D and 2D Color Graphics Workstations and Terminals present users with the ultimate in choice for high-performance graphics systems. Both graphics workstations and terminals are offered in 3D or 2D with a selection of features that truly reflects the specific needs of graphics users. Tek anticipates growth paths by offering easy upgrade from terminal to workstation. And while introducing new graphics systems, Tek also protects investment in current Tek products by offering local computing resources for 4100, 4120 and 4200 Series terminals.

Graphics Workstations

The NEW 4310 Series of Graphics Workstations offers customers entry-level workstations with Tek-quality performance and display. Designed to meet user needs exactly, the 4310 Series offers monochrome, grayscale, or color display.

Applications Software

PLOT 10® Applications Software and Standard Tools expand Tek's standard-setting family of graphics software with enhanced design and presentation software, increased portability from other applications, and the NEW PHIGS library of subroutines to aid development of interactive graphics applications.

Color Output Systems

The NEW 4693 Color Output Systems introduce a new technology: thermal wax printing. Offering quality printing, full color, and fast processing, thermal wax technology is available in a standalone color printer and, for highest quality, in a rasterizer system. All Tek color output products combine to offer a range of price/performance, and now include compatibility with IBM systems.

As always, Tektronix provides a complete offering of graphics supplies.

NEW PC GRAPHICS

- **Powerful PC4100 Graphics Coprocessor Board for IBM XT and AT Personal Computers**
- **Tektronix 4105 and 4107 Terminal Emulation Software**
- **PCD13 Multiple-Rate Color Graphics Monitor**

Tektronix introduces an integrated system of high-performance graphics for the user of advanced PC graphics. The PC4100 Graphics Coprocessor Board offers new levels of speed and support. Together with PC-05 or PC-07 terminal emulation software, IBM XTs and ATs can use Tektronix and other popular mainframe graphics applications written for Tek 4105 and 4107 terminals. And the PCD13 Color Graphics Monitor provides high-quality, balanced resolution.

NEW PC4100

Coprocessor Board

- **1M Byte Program Memory Plus 512K Bytes Video Memory**
- **Color Palette of 16.7 Million Shades; 256 Displayable at Once**
- **Based on TI's Powerful TMS34010 Graphics System Processor**
- **Support for Application Development Through PLOT 10® Tektronix Graphics Interface (TGI™) for PCs**
- **EGA and CGA Emulation with Soft-Switching**
- **Compatible with Many Popular Input Devices and Printers**

The Tektronix PC4100 Graphics Coprocessor uses parallel processing and state-of-the-art VLSI technology to support superior graphics performance for IBM XTs and ATs (and compatibles) running MS-DOS Version 2.0 or higher. The PC4100 frees up PC power and increases processing speed by controlling the display and creating and manipulating graphics without host involvement. A command set optimized for both pixel and vector operations ensures rapid execution of graphics commands.

Easy Access to Many Graphics Applications

The PC4100 Graphics Coprocessor provides IBM Enhanced Graphics Adapter (EGA) emulation, allowing immediate access to the full range of EGA-based graphics applications like Lotus 1-2-3, Microsoft Word, and others.

The PC4100 also supports several popular software packages for high-performance graphics in local Tek mode such as VersaCAD, AutoCAD, Zenographics' Mirage and Dr. Halo.

Programmers can develop high-performance application software for the PC4100 with PLOT 10 Tektronix Graphics Interface (TGI). By relying on the basics of Tek graphics for PC application programs running MS-DOS, TGI gets top performance out of graphics applications. It includes primitives for lines, markers, panels and graphtext. The application handles graphics input while TGI supports cursor tracking, rubberband lines and rubberband boxes. The PC4100's soft-switch feature makes it easy to move among EGA, CGA and Tek modes.

Extensive Color Palette

A palette of more than 16.7 million shades provides smooth shading and brilliant coloring for graphics. Selecting color is a simple process, with 256 colors displayable at once.

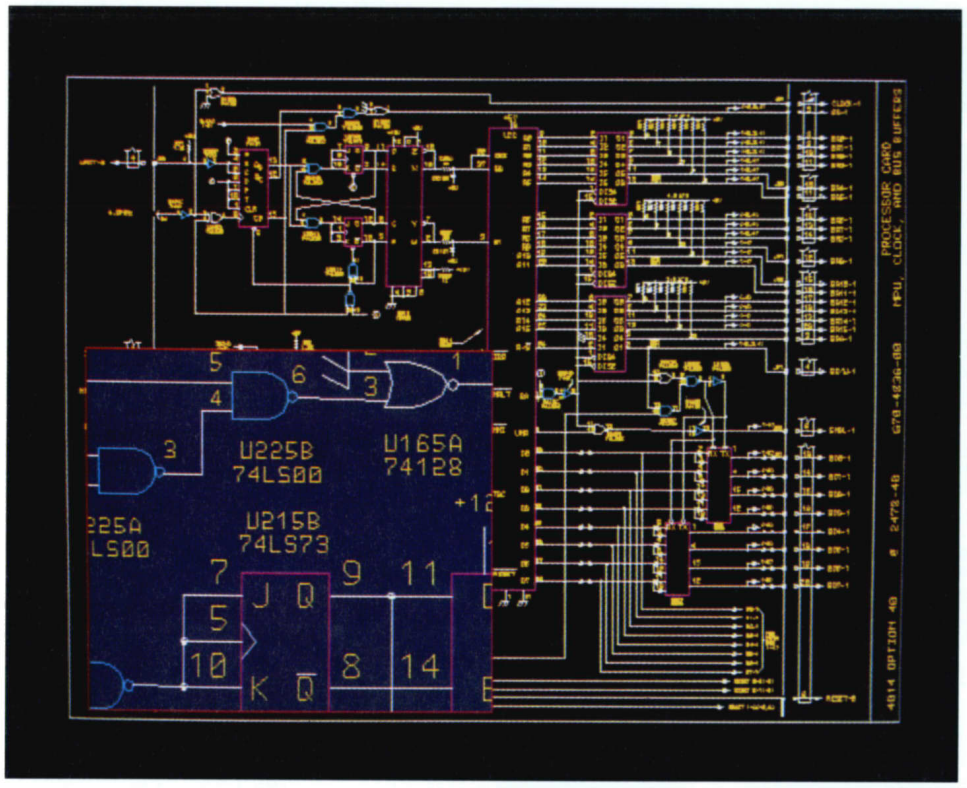
Powerful Memory Support

With 1M byte of DRAM memory and an additional .5M bytes of VRAM display or frame buffer memory, users can manipulate display list information and define complex images. The general-purpose DRAM supports Tek's PLOT 10 TGI, custom microcode for special graphics requirements, and other custom graphics software applications. It also stores graphics images in pixel or display list form for high-performance drawing.

Simple, Flexible Printing

In Tek mode, the PC4100 supports Tektronix 4696 and 4692 Ink-Jet Printers, producing vibrant color output on paper and transparencies. The PC4100 also supports the Epson FX-80 monochrome printers and the IBM ProPrinter.

TGI is a trademark, and PLOT 10 is a registered trademark, of Tektronix, Inc.



PC-05 and PC-07 allow PC access to powerful host-based graphics.

NEW PC-05 and PC-07

Terminal Emulation Software

- **PC-05 Supports Points, Vectors, Polygons, Graphtext, Graphics Input**
- **PC-07 Provides True Local Zoom and Pan, Multiple Surfaces, 64 Windows, Extended Graphics Input**
- **DEC VT100 Emulation**

Tektronix PC-05 and PC-07 Terminal Emulation Software provide IBM XT or AT (and compatibles) users with Tek graphics and VT100 alphanumerics, accessed via the PC4100 Coprocessor Board. When connected to an appropriate host, an IBM XT, AT or compatible system can use host-based application software packages that offer driver support for Tek's 4105 and 4107 Computer Display Terminals. PC-05 and PC-07 software support Tek PLOT 10 tools, including PLOT 10 Graphical Kernel System (GKS), and Tek 4010/4014 terminal applications.

To maintain high performance, PC-05 and PC-07 software use the PC's CPU memory for local processing, reducing the host's compute burden and improving system performance. Graphics images can be stored locally on disk for easy restoration.

Flexible Input and Printing

PC-05 and PC-07 software support a variety of popular PC input devices: Mouse Systems Optical Mouse, AT and T Mouse, LogoTech Mouse, Microsoft Serial Mouse, Summagraphics Mouse and Tablets, Kurta Series Tablet, Hitachi Tiger Tablet, and Atari Trakball.

PC-05 and PC-07 software support the Tektronix 4696 Ink-Jet Printer, Diablo C150 Color Printer, and Epson JX-80 color printers and compatibles. They also support the Epson MX-80, FX-80, GX-80, and RX-80 monochrome printers, HP LaserJet+, Tek 4644 Dot Matrix Printer, and IBM ProPrinter.

NEW PCD13

Color Graphics Monitor

- **For Use with PC4100**
- **13-Inch Diagonal Viewing Area**
- **Balanced 640×480, 640×400 or 640×350 Addressability**

The PCD13 Color Graphics Monitor provides 640×480 balanced display resolution and alternate resolutions of 640×400 and 640×350. The multiple-rate PCD13 Monitor supports EGA and CGA emulation. The 0.26 mm dot pitch ensures flicker-free display, and the 60 Hz noninterlaced refresh rate provides sharp, clear images. The monitor's silica glass coating and flat Trinitron CRT face minimize glare and light reflections. A tilt-swivel monitor pedestal offers convenience and flexibility.

ORDERING INFORMATION

PC4100 Graphics Coprocesor Board **$1,595**
Requires IBM XT or AT personal computer or compatible system with MS-DOS Version 2.0 or higher, one hard-disk drive, and one flexible-disk drive.
Includes: Board, video interface cable, Operator Manual (070-6425-00), power cord, three software accessory disks, optional Programmer Manual (070-6420-00), optional Introduction to Computer Graphics (070-5239-01).

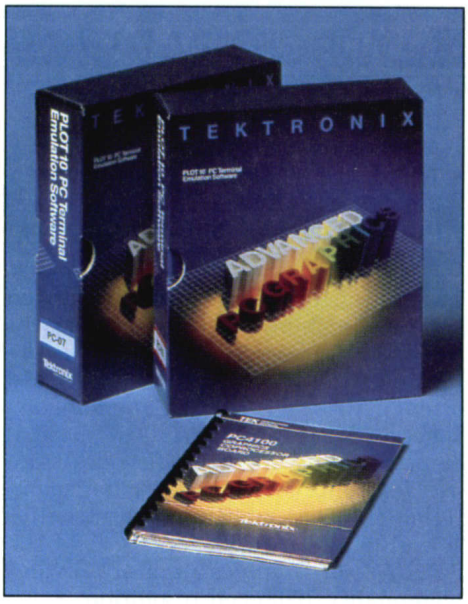
PC-05 Terminal Emulation Software **$495**
Requires 128K bytes memory.
Includes: Disks, User Manual (070-6424-00), optional Programmer Manual (070-4526-03), optional Reference Guide (070-4528-02).

PC-07 Terminal Emulation Software **$995**
Requires 256K bytes memory, or 640K bytes if applications make heavy use of segments.
Includes: Disks, User Manual (070-6424-00), optional 4106/07/09/CX Programmer Manual (070-4893-01), optional 4106/07/09 Reference Guide (070-4892-02).

PCD13 Multiple-Rate Color Graphics Monitor **$895**
Includes: Video interface cable, Operator Manual (070-6402-00), power cord, optional Service Manual (070-6422-00).

INTERNATIONAL POWER PLUG OPTIONS
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
See Customer Service.



4200

Series Graphics Terminals

- **Multipurpose Terminals with Advanced Alphanumeric and Color Graphics Features**
- **IBM 3270 and DEC Compatibility**

Tektronix color graphics terminals provide Tek graphics with advanced features, at affordable prices, and in a range of fully compatible terminals.

The *NEW* 4209 provides higher performance color graphics, while the *NEW* SF4208 is built for CIM performance and manufacturing environments. The 4205 is a low-cost entry point product. The 4207 and 4208 are performance leaders in desktop graphics—the 4208 adds even more functionality.

Tektronix Graphics for DEC and IBM Environments

Tektronix provides users in both DEC and IBM environments with Tek graphics—the standard for scientific and engineering applications—plus exceptional compatibility with DEC and IBM applications. DEC users now have VT200 compatibility; IBM users have GDDM compatibility. Tek also opens up DEC and IBM environments to a large base of other graphics applications.

Software Compatibility

4200 Series terminals accept programs written for Tek 4100 Series terminals. Software support includes Tektronix PLOT 10® TekniCAD™, TekniCAP™, STI, GDI, GKS, IGL; Computer Associates' DISSPLA and TELL-A-GRAPH; SAS Institute's SAS/GRAPH; and many others.

Advanced Intelligent Graphics Capability

Performance and productivity are improved by enhanced segment operations, local zoom and pan, and multiple view functions. Local memory and graphics intelligence allow the user to define objects at the host, save them in the terminal,

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4200 SERIES AND 4111 TERMINAL SELECTION GUIDE

Applications/Features	4205	4207	4208	SF4208	4209	4111
Display size	13-inch	13-inch	13-inch	13-inch	19-inch	19-inch
Displayable colors from 64 Graphics Alphanumeric	 16 8	 16 8	 16 8	 16 8	 16 8	 16 8
Addressable points	480×360	640×480	640×480	640×480	640×480	1024×768
Virtual graphics coordinate space	4096×4096	4096×4096	4096×4096	4096×4096	4096×4096	4 billion×4 billion
Expanded segment support	Yes	Yes	Yes	Yes	Yes	Yes
Local zoom & pan	Yes	Yes	Yes	Yes	Yes	Yes
Arc and circle commands	Yes	Yes	Yes	Yes	Yes	Yes
Pixel operations	Yes	Yes	Yes	Yes	Yes	Yes
Two-port peripheral interface	No	Yes	Yes	Yes	Yes	Yes
Color & monochrome copier support	Yes	Yes	Yes	Yes	Yes	Yes
4957/58 Tablet support	No	Yes	Yes	Yes	Yes	Yes
System memory, standard (bytes)	128 K	256 K	512 K	512 K	512 K	256 K
Optional additional megabytes of memory	1.0	1.0	1.0	1.0	1.0	1.0
4510A support	No	Yes	Yes	Yes	Yes	Yes
Prices begin at (U.S. end user)	$2,495	$3,995	$4,995	$5,495	$6,995	$8,995

and then manipulate and edit them locally with only minimum interaction with the host.

True local zoom and pan rescales images using the full addressability of the terminal's 4096-by-4096 coordinate space. Users can enlarge an image to view it in detail, and they can pan beyond the image displayed on the screen to zoom in on a portion of the image not currently displayed. These powerful functions are handled locally by the terminal and do not require host interaction.

The 4200 user can display up to 64 views in independent viewports on the screen, allowing comparison of graphics information, simultaneous viewing of different views of one object, or the display of time series data.

The 4200 Series is ANSI X3.64 compatible and supports standard industry alphanumerics. The 4200 user can define custom character fonts on the host computer to fit specific applications and then download them for use on a 4200 terminal.

The 4200 Series supports Tek's 4690 Series Color Copiers and popular low-cost printers such as the HP ThinkJet, Epson FX-80, and others. The 4208, with RGB video output, supports Tek's 4632 Copier. A background copy feature frees the computer for continued use while it makes hard copies.

In addition to the graphics input device on the keyboard, the 4200 Series supports an optional mouse, plugged directly into the keyboard. The 4200 Series, except for the 4205, also supports Tek's 4957 and 4958 Graphics Tablets.

VT200 Compatibility

DEC users now have access to high-performance Tek graphics, the Tek family of peripherals, and long-term support for an upward migration path. The 4200 Series provides complete alphanumeric compatibility with DEC's VT200 family. Tek's VT200 keyboard supports most Tektronix 4100 and 4200 Series applications and VT200 applications without modification.

GDDM Compatibility

Tek brings the performance advantages of Tek graphics to the IBM world while maintaining compatibility with existing GDDM applications. Both high-performance Tek graphics and existing GDDM applications are supported, giving the user the widest graphics choices available.

Users with IBM hosts now have access to segments, local zoom and pan, 4K-by-4K addressability, surfaces, viewports, and extensive graphics input features like inking and rubberbanding. These features let the user run a wide variety of host applications with less host computing resources.

GDDM compatibility offers access to a variety of existing applications. Users can access up to five IBM host sessions, changing sessions by pressing just one key. The 4200/CX Series terminals have dual-host connections, so they can be linked simultaneously to an IBM host and a DEC or other RS-232 host.

Sealed Keyboard for Manufacturing Environments

To protect your computer investment from harsh environments, Tektronix offers the fully-functional, full-travel sealed keyboard option for the 4200 Series terminals. Providing protection from liquids, dust and chips, Tek's sealed keyboard has no openings that could trap chips or cause malfunctions. Standard equipment with the SF4208, and optional with the 4207, 4208, 4209 and 4111 terminals, the keyboard comes in IBM 3270, VT100 and VT200 models. (Mouse input is not available with the sealed keyboard.)

Flexible leasing programs available in the continental U.S.

4205

Color Graphics Terminal

- **The Most Affordable Tek Color Graphics Terminal**
- **Compatible With Tektronix 4100 Graphics Terminal and the 4207, 4208, and 4209 Terminals**

The 4205 Color Graphics Terminal brings high-performance color graphics at a low price within reach of every computer user. The 4205 offers Tektronix' industry-standard color graphics. The 4205 offers outstanding general purpose alphanumerics with high-quality color graphics.

The 4205 has a flicker-free, 60-Hz non-interlaced refresh rate and a 0.31 dot pitch 13-inch (330-mm) color display screen. Balanced resolution of 480×360 pixels produces distortion-free pictures that rival more expensive and higher-resolution terminals. Background copy spooling to color copiers, 4096×4096 virtual graphics coordinate space, and true local zoom and pan make the 4205 a price/performance leader.

Graphics Features

The 16 graphic and 8 dialog colors, from a palette of 64, allow color differentiation in complex drawings and graphs. Other graphics features include multiple views, multiple surfaces, circles and arcs, user-definable cursors, and an optional additional megabyte of system memory.

4205 Color Graphics Terminal.

4207

Color Graphics Terminal

- **Desktop Color Graphics Terminal Leader**
- **Compatible with Tektronix 4100A, 4205, 4208, and 4209 Terminals**

For advanced graphics applications, the sophisticated 4207 Color Graphics Terminal is the price/performance leader. With graphics capabilities, such as background spooling to a color copier, the 4207 rivals more costly graphics terminals. The 640×480 pixel resolution is enhanced by the flicker-free, 60-Hz noninterlaced refresh rate, precision in-line gun with fixed convergence, and anti-glare-etched 13-inch (330-mm) display screen. Addressability is 4096×4096 points, with true local zoom and pan making effective use of this precision.

Graphics Features

The graphics area supports 16 colors from a palette of 64. Other graphics features include multiple views, multiple surfaces, arcs, user-definable cursors, tablet support and an additional one megabyte of system memory. Also included are eight predefined line styles, 11 marker types, and 149 predefined solid or dithered patterns for polygon filling. Two styles of graphics text may be scaled, rotated, and adjusted in size.

The 4207 supports a wide variety of copiers and printers for both graphics and dialog copies. These include the popular Tektronix 4692 and 4696 Color Graphics Copiers, the HP ThinkJet and LaserJet, the Epson FX-80, and many other Epson-compatible printers. The 4207 also supports the Tektronix 4957 and 4958 Graphics Tablets.

4208

Color Graphics Terminal

- **Compatible with Tektronix 4100A, 4205, 4207 and 4209 Terminals**
- **RGB Video Output**

The 4208 Color Graphics Terminal shares the advanced graphics capabilities and features of the 4207, and adds enhanced functionality.

More Standard Memory

The 4208 has 512K bytes standard system memory to support more demanding applications utilizing Tek intelligent graphics features.

RGB Video Output

RGB video output supports color camera systems, remote monitors, and the Tek 4632 Copier. The 4208 is compatible, via RGB video output, with large-screen projectors, and supports color-camera output devices. It also supports the HP LaserJet Printer and the Tek 4957 and 4958 Graphics Tablets.

Physical Package

The 4208 physical package is built for flexibility. Cooling vents on the side box, rather than on top, make the 4208 appropriate for non-office environments.

Output

High-quality color copies of 4208 images can be produced on paper or transparency film, using the Tektronix 4690 Series Color Graphics Copiers. Background copying allows users to spool graphics copies for minimal terminal interruption.

NEW 4209

Intelligent Color Graphics Terminal

- **19-Inch Display**
- **512K Bytes Memory**
- **Extensive Software Support**
- **VT100 and VT200 Compatibility**

The *NEW* Tektronix 4209 Intelligent Color Graphics Terminal is ideal for CAD, mapping, and large-screen presentation applications, bringing local graphics intelligence and outstanding display quality to engineering and scientific environments.

512K bytes of standard memory support graphics intelligence resident in the 4209, allowing local redraw and manipulation of graphics without host intervention and reducing host communication time.

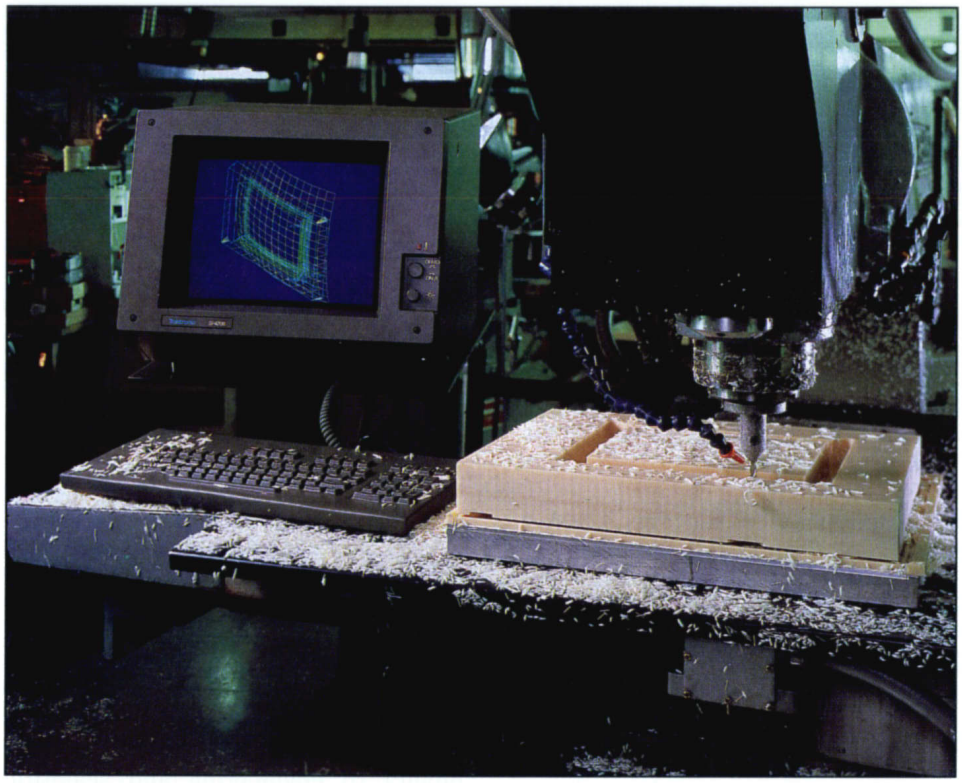
The 4209 offers 16 simultaneous colors from a palette of 4096, and has a user-defined dialog area from 2 to 32 lines long. Text resides in a separate plane so on-screen graphics are not disturbed during host communications.

Views and Surfaces

The Tek 4209 supports 64 user-definable separate views displayable in independent viewports. It simplifies graphics creation by making surfaces visible or invisible and combining surfaces and views to create multi-level images. The 4209 features true local zoom and pan, with zoom display at 4096×4096 addressability.

Built-In Compatibility

The 4209 is compatible with programs written for Tek 4010, 4100, and 4200 terminals. It complies with industry standard ANSI X3.64 and VT100/VT200 alphanumerics. A CX option provides coaxial connection to IBM 3270/3174 environments and 3179 alphanumeric and graphics emulation (GDDM). Compatible software includes Tek PLOT 10 packages and advanced graphics applications from SAS Institute, ISSCO, Precision Visuals, SDRC, PDA, MCS and more.



SF4208 Industrial Color Graphics Terminal.

NEW SF4208

Industrial Color Graphics Terminal

- **Tektronix 4200 Graphics Performance**
- **Sealed Keyboard**
- **Overheat Sensor with Automatic Shutdown**
- **512K Bytes Memory**
- **RGB Video Output**
- **Optional IBM 3270 Coax Interface**

The Tektronix SF4208 Industrial Color Graphics Terminal offers the full graphics performance of the 4200 Series Color Graphics Terminals combined with the construction to withstand the rigors of the shop floor. The SF4208 is suitable for a wide range of manufacturing applications including mechanical drawing preview, numeric control tool path simulation, production assembly and process control.

The SF4208 terminal offers a unique sealed keyboard to keep out spills and dirt while maintaining full functionality. The chassis incorporates a special filtered cooling system to protect the terminal from air-borne particles and dripping liquids. The SF4208 CRT shield is glare- and impact-resistant and static-grounded.

The SF4208 operates in harsher conditions than the typical terminal—from 0 to 50 °C—and under relative humidity between 10 and 95%, noncondensing. If the terminal gets too hot, a sensor warns the operator by illuminating an LED on the front panel. The terminal will even shut down automatically, if needed. The SF4208 offers the same high-quality Tek graphics, software support and compatibility as the Tek 4208. (Mouse input is not available with the SF4208.)

4111

Color Graphics Terminal

- **Advanced Firmware Routines**
- **Four Bit Planes for Multilayer Graphics**

The 4111 Color Graphics Terminal is a personalized, high-resolution computer display terminal that offers superior price/performance characteristics for 2D ME-CAD and drafting applications, EE-CAD (schematic capture, IC design), cartography, and Technical Data Analysis (TDA). The terminal operates in a 60-Hz, noninterlaced mode that minimizes both flicker and eye strain. An anti-reflection enhancement panel further minimizes user fatigue.

Four bit planes are standard, allowing the simultaneous display of 16 colors for graphics, eight of which can be used in the dialog area. Each bit plane can be treated as a separate display surface permitting the manipulation of layers of data—a feature that is particularly useful with multilayer drawings such as IC design and printed circuit board design.

The 4111 offers an extensive set of graphics functions including windowing, multiple views, segments, surface support, and local zoom and pan. A majority of 256K bytes of local RAM is available to store picture elements for later use; 1M byte can be added optionally to bring the total RAM memory up to 1.2M bytes.

Advanced firmware routines aid the applications programmer in developing graphics software with a very interactive operator interface and excellent performance. Included in the 4111's firmware are routines that handle segment editing, segment subroutines, pick operations, host window management, multiple scrolling dialog areas, and pop-up menus.

ORDERING INFORMATION

4205 Color Graphics Terminal **$2,495**
Includes: Power cord (161-0066-09). RS-232 cable (012-0911-00); standard keyboard (119-1989-01); Operator Manual (070-6279-00); Reference Guide (070-6046-01); An Introduction to Computer Graphics (070-5239-01).

4207 Color Graphics Terminal **$3,995**
Includes: Same as 4205.

4208 Color Graphics Terminal **$4,995**
Includes: Same as 4205, except Operator Manual (070-6045-00).

SF4208 Industrial Color Graphics Terminal **$5,495**
Includes: Power cord (161-0234-00); RS-232 cable (012-0911-00), standard sealed keyboard (119-2632-00); Operator Manual (070-6426-00); Operator Card (070-6427-00); Reference Guide (070-6046-01); An Introduction to Computer Graphics (070-5239-01).

4209 Intelligent Color Graphics Terminal **$6,995**
Includes: Same as 4205, except Operator Manual (070-6340-00).

4111 Color Graphics Terminal **$8,995**
Includes: Power cord (161-0066-00); RS-232C cable (012-0911-00); Operator Manual (070-5683-01); 4110/4120 Series Reference Guide (070-5142-02); An Introduction to Computer Color Graphics (070-5239-01); function key overlays (package of six) (334-3290-02); standard keyboard (119-2208-00); IDG user's survey card (062-7235-01).

OPTIONS

Option 4M—Mouse **+$150**
Option 2C—(4111) Additional 1M byte memory **+$750**
Option 22—(4205/4207/4208/4209/SF4208) Additional 1M byte memory **+$750**

Interface and keyboard for IBM 3270 coaxial environments and international keyboards are available. Contact your local Sales Representative.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50-Hz.
Option A2—UK 240 V, 50-Hz.
Option A3—Australian 240 V, 50-Hz.
Option A4—North American 240 V, 60-Hz.
Option A5—Switzerland 220 V, 50-Hz.

WARRANTY-PLUS SERVICE PLANS

See Customer Service.

Flexible leasing programs available in the continental U.S.

Tektronix Introduces Three New Families of Full-Performance Graphics Workstations and Terminals

4336 and 4335 3D Graphics Workstations.

4236 and 4235 3D Graphics Terminals.

New Graphics Workstations and Terminals

- **4330/4230 Family of 3D and 2D Graphics Workstations and Terminals with Dynamic Motion and True Color**
- **4320/4220 Family of 2D Workstations and Terminals with Sophisticated Color Graphics**
- **4310 Series of Low-Cost Workstations**

Tektronix continues to provide the graphics world with the best in price/performance value in its new series of graphics workstations and terminals. Offering the serious graphics user a selection of 3D and 2D, terminal or workstation, and an ability to upgrade terminals to workstations, Tek meets the need for performance, value and versatility in the graphics environment.

3D Workstations and Terminals

The 4330/4230 Family provides a range of color graphics workstations (4330 Series) and terminals (4230 Series) with 3D and 2D capabilities. Do you need a full performance graphics workstation or does a graphics terminal meet your requirements? Either way, you'll get Tektronix-quality graphics and performance. And you'll select a workstation or terminal that has just the performance level, displayable colors and display size you need.

2D Workstations and Terminals

The 4320/4220 Family offers a range of 2D color graphics workstations (4320 Series) and terminals (4220 Series). Whether you select a workstation or terminal, you'll choose from a variety of products to meet your needs.

Tek Plans for Growth

The 4330/4230 and 4320/4220 families offer easily-installed kits to upgrade your terminal to a workstation. You can select a 4230 3D terminal, knowing that any time you want a 4330 3D workstation instead—with 2.5 MIPS additional processing power and full-color graphics capabilities—Tek makes it easy to upgrade. Or you can begin with a 4220 2D terminal and upgrade to a 4320 2D workstation.

Entry-Level Workstations

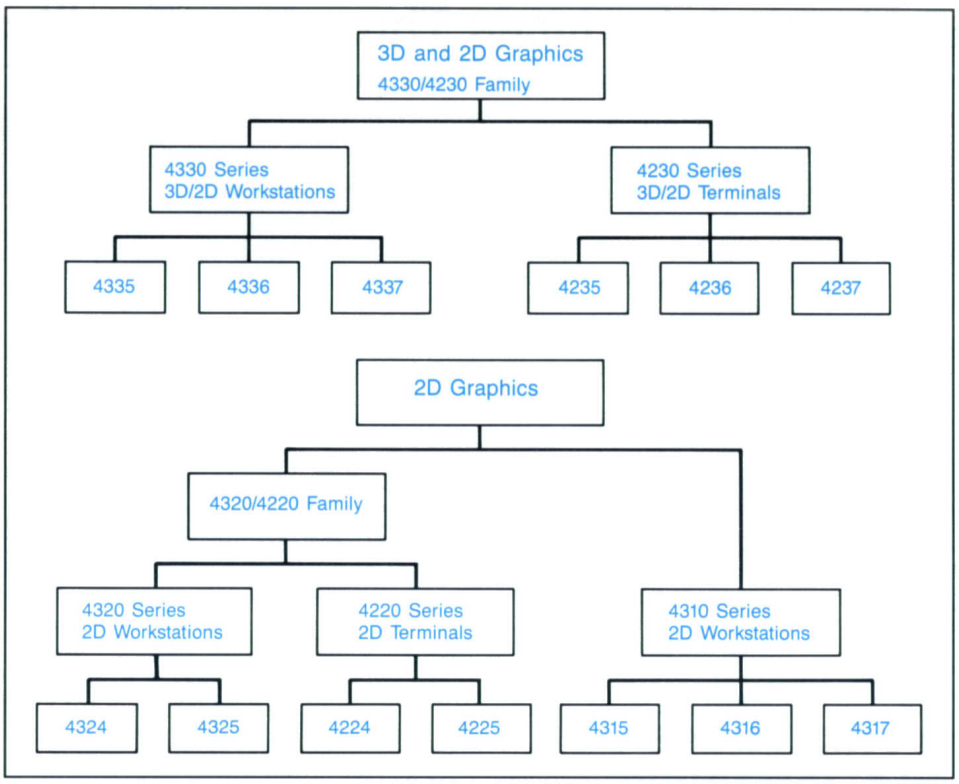
The 4310 Series—the 4315, 4316 and 4317 Graphics Workstations—combine high performance with software and programming support in a low-cost, efficient engineering workstation.

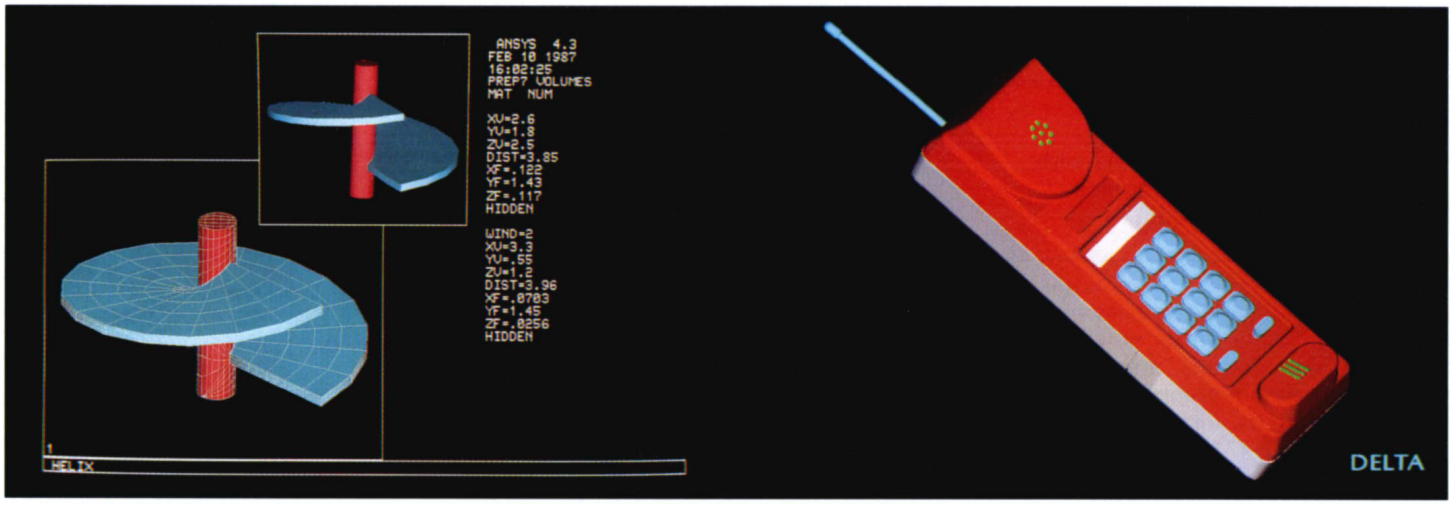
How to Find the Right Tektronix Graphics Workstations and Terminals for You

As Tektronix introduces our new families of graphics workstations and terminals, you may be confused about how to find the right equipment. Here's how to use this catalog to make the best selection of Tektronix graphics systems.

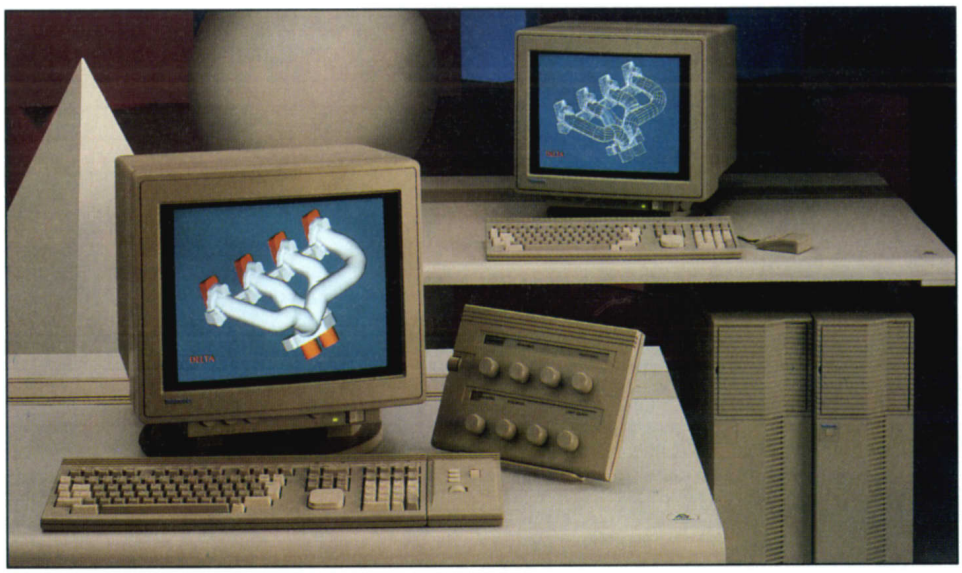
The family tree describes the three families we're introducing: one for 3D and 2D graphics, and two for 2D graphics. Two of the families offer both workstation and terminal configurations.

Tektronix offers several product choices within each Series so that you can select the specific qualities you need. In the following pages, you'll find a summary of the performance and graphics features of each Family, followed by brief descriptions of each product that list only the unique features of that product. To understand the product you're interested in, read the Family information as well as the list of distinguishing features.





4330 screens with Ansys (left) and Delta (right) software.



NEW 4330/4230 FAMILY

3D/2D Graphics Workstations and Terminals

- **Integrated Workstation or Host/Network-Connected Terminal Configurations**
- **20 MHz 68020/68881 Workstation CPU, with Optional Floating Point Accelerator**
- **16.7 MHz 68020/68881 Graphics Engine**
- **UNIX-based UTek™ Operating System with System Administration Interface, On-Line Tutorials and On-Line Help**
- **Pipelined Architecture and Custom Gate Arrays for Maximum Graphics Performance**
- **True Color Capability with up to 24 Bit Planes**
- **3D Wireframe, Shaded Surface and Stereoscopic Representations**
- **Supports High-Performance 2D Graphics**
- **Support for X Windows, Ethernet, TCP/IP and Sun NFS**
- **System Software Includes IBM PC/XT Emulation and C, with Optional FORTRAN, Pascal and UNIFY Data Base Manager**
- **4M Bytes System Memory, Expandable to 12M Bytes**
- **86M Bytes Hard Disk, 156M Bytes and 234M Bytes Optional**

UTek is a trademark of Tektronix, Inc.

The Tektronix 4330 Graphics Workstations and 4230 Terminals deliver the 3D and 2D graphics features set that Tek pioneered in the 4120 Series, now enhanced to provide even higher performance.

High-Performance Processing

The 4330/4230 Family offers excellent graphics price/performance. Motorola's 68020 16.7 MHz processor manages the display list, ASCII command processing, and input/output. Three microcoded engines, including a bit-sliced engine, accelerate graphics data manipulation. 4M bytes of graphics memory (3M bytes available to the user as display list memory) are standard with an additional 48M bytes optional.

The 4330 Series Workstations operate with two 68020 processors, working together to boost total applications performance. The applications processor operates at 20 MHz and is augmented by the 68881 floating point processor—and an optional floating point accelerator.

Tektronix' UTek Operating System is a powerful implementation of Berkeley 4.2 UNIX. With a number of extensions from System V, UTek facilitates system administration and maintenance.

The Right Features for 3D Graphics

Displayed objects can be shaded via constant, cosine or Gouraud shading methods. Users can select from 16 predefined translucency patterns and specify ambient light intensity and direction for up to 16 sources of white light for each of 64 possible views. Objects can be viewed in parallel or perspective projection, sectioned, clipped, rolled and rotated.

Graphics segments and a 32-bit virtual graphics coordinate space (24 bits for 3D graphics) support true zoom and pan. Segment editing and subroutining, and the powerful DRAW FACETS command, provide high-level programming entities. Tek has expanded its patented implementation of matching segment classes so they can be "picked" for graphics input.

The 4330/4230 Family offers high-performance 2D graphics capability, with 2D speeds five times faster than available in the 4320/4220 Family.

Easy Handling of Graphics Data

For entering and manipulating graphics data, 4330/4230 systems include a VT220-compatible modular keyboard with a cursor pad and optional thumbwheels. A mouse is standard with the workstations and optional with the terminals. An optional Valuator Dial Box provides 8 fully-programmable graphics input controls for the greatest productivity in manipulating 3D graphics.

To support the dense graphics used in scientific and engineering applications, all systems come with 4M bytes of display memory, with 3M bytes available to the user. Additional memory is available in 16M byte increments, with a total of 52M bytes (51M bytes available to the user).

Superior Display Quality

The 4330/4230 systems offer a choice of 16 or 19-inch color displays with 1280×1024 addressable points for an exceptionally crisp image. For flicker-free viewing, displays operate at 60 Hz, non-interlaced. True stereoscopic viewing (available as an option) provides alternate left-eye, right-eye views at a rate of 115 Hz.

Plenty of Mass Storage

The 4330 Workstations include an 86M byte hard disk and a 1.2M byte flexible disk for mass storage. Optional additions are 156M byte or 234M byte hard disks, a 60M byte cartridge tape, and a 360K byte flexible disk. For storing even more data, the Tektronix 4944 Mass Storage Unit supports a variety of streamer tape, hard disk and flexible disk options.

Extensive Compatibility with Software Applications

Compatibility with Tek's 4120 Series and new 4320/4220 Family allows hundreds of previously-developed applications to run with few or no changes, providing the flexibility to select the most useful combination of software and hardware. To simplify software porting, the workstations support industry standards like UNIX, X Windows, and FORTRAN.

TABLE 1. 4330/4230 FAMILY PERFORMANCE CHARACTERISTICS

	4335 Workstation	4336 Workstation	4337 Workstation	4235 Terminal	4236 Terminal	4237 Terminal
System Processors	68020 @ 20 MHz 68881 coprocessor	68020 @ 20 MHz 68881 coprocessor	68020 @ 20 MHz 68881 coprocessor			
Optional Accelerator	Floating pt. accel.	Floating pt. accel.	Floating pt. accel.			
Graphics Processor	68020 @ 16.7 MHz	68020 @ 16.7 MHz	68020 @ 16.7 MHz	68020 @ 16.7 MHz	68020 @ 16.7 MHz	68020 @ 16.7 MHz
Bit Planes Maximum	4 8+8	8 8	12 24	4 8+8	8 8	12 24
Display Modes	2D, 3D wireframe	2D, 3D wireframe, hidden line, shaded surface, double buffered	2D, 3D wireframe, hidden line, shaded surface, double buffered, true color	2D, 3D wireframe	2D, 3D wireframe, hidden line, shaded surface, double buffered	2D, 3D wireframe, hidden line, shaded surface, double buffered, true color
Optional Display	Stereoscopic	Stereoscopic	Stereoscopic	Stereoscopic	Stereoscopic	Stereoscopic
Displayable Colors Maximum	16 256	256 256	4,096 16.7M	16 256	256 256	4,096 16.7M
Display Size	406 mm (16 in.)	406 mm (16 in.)	406 mm (16 in.)	406 mm (16 in)	406 mm (16 in.)	406 mm (16 in.)
Optional Display Size	483 mm (19 in.)	483 mm (19 in.)	483 mm (19 in.)	483 mm (19 in.)	483 mm (19 in.)	483 mm (19 in.)
Addressability	1280 × 1024	1280 × 1024	1280 × 1024	1280 × 1024	1280 × 1024	1280 × 1024
System Memory (bytes) Maximum (bytes)	4M 8 or 12M	4M 8 or 12M	4M 8 or 12M			
Display Memory (bytes) Maximum (bytes)	4M 20, 36, or 52M	4M 20, 36, or 52M	4M 20, 36, or 52M	4M 20, 36, or 52M	4M 20, 36, or 52M	4M 20, 36, or 52M
Mass Storage (bytes)	86M hard disk, 1.2M flexible disk	86M hard disk, 1.2M flexible disk	86M hard disk, 1.2M flexible disk			
Optional Mass Storage (bytes)	156 or 234M hard disk, 60M cartridge tape, 360K flexible disk	156 or 234M hard disk, 60M cartridge tape, 360K flexible disk	156 or 234M hard disk, 60M cartridge tape, 360K flexible disk			
Interfaces	Dual RS-232C, LAN, Second RGB output, SCSI, Color printer	Dual RS-232C, LAN, Second RGB output, SCSI, Color printer	Dual RS-232C, LAN, Second RGB output, SCSI, Color printer	Host RS-232C, Dual RS-232C, LAN, Second RGB output, Color printer	Host RS-232C, Dual RS-232C, LAN, Second RGB output, Color printer	Host RS-232C, Dual RS-232C, LAN, Second RGB output, Color printer
Optional Interfaces	Additional RS-232C, Dual Centronics I/FS	Additional RS-232C, Dual Centronics I/FS	Additional RS-232C, Dual Centronics I/FS	Interactive DMA	Interactive DMA	Interactive DMA
System Software	UTek, C, X Windows 10.4, PC software support	UTek, C, X Windows 10.4, PC software support	UTek, C, X Windows 10.4, PC software support			
Optional Software	Pascal, UNIFY, ACCELL	Pascal, UNIFY, ACCELL	Pascal, UNIFY, ACCELL			
Supported GIN Devices	Thumbwheels, tablets, mouse, valuator dials, cursor pad	Thumbwheels, tablets, mouse, valuator dials, cursor pad	Thumbwheels, tablets, mouse, valuator dials, cursor pad	Thumbwheels, tablets, mouse, valuator dials, cursor pad	Thumbwheels, tablets, mouse, valuator dials, cursor pad	Thumbwheels, tablets, mouse, valuator dials, cursor pad
Supported Tek Color Printers	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D

Tektronix PLOT 10® TekniCAD™ and TekniCAP™ are supported, and PLOT 10 Standard Tektronix Interface (STI) and Terminal Control System (TCS) have been enhanced to provide fast access to the 4330/4230 Family.

Software emulation of the IBM PC/XT is also standard, allowing the workstations to run a variety of PC/XT-based applications.

The 4330 Workstations and 4230 Terminals include a local area network port (IEEE 802.3) as well as dual RS-232C, Centronics-style, and Small Computer System Interface (SCSI) ports. Multiple RS-232C DMA ports and additional Centronics-compatible interfaces can be installed.

Tektronix and Industry Standards

The 4330 Workstations include industry-standard implementations of C, with FORTRAN 77 and ISO Pascal available as options.

In addition to the Tektronix PLOT 10 graphics standards, the 4330 Workstations implement UTek, Tektronix' powerful UNIX-based operating system. UTek's menu-based **sysadmin** interface simplifies the most complex system tasks, including network and system administration.

Networking is supported by an IEEE 802.3 Ethernet interface and the standard TCP/IP protocol. For file management across the network, the 4330 Series uses Sun Microsystems' Network File System (NFS)*.

Output Support

The 4330 Workstations and 4230 Terminals support Tek's new 4693D Color Image Printer which prints up to 16 million shades at 300 dots-per-inch addressability. Built-in color interfaces provide driver connection and hardware support for the Tektronix 4696 and 4692 Color Ink-Jet Printers. 4330/4230 Workstations and Terminals are free for other use while files are printing.

* *Sun Microsystems' NFS will be available in Spring 1988.*

TekniCAD and TekniCAP are trademarks of Tektronix, Inc.
PLOT 10 is a registered trademark of Tektronix, Inc.

NEW 4330 SERIES

3D/2D Graphics Workstations

Tektronix offers a selection of 3D graphics workstations to meet users' graphics computing needs. Each of the three 4330 Workstations shares the features and performance described in the preceding paragraphs and in Table 1. In addition, each one has specific features designed to meet the range of display quality and flexibility required by graphics users. The differing features of each workstation are listed below.

4335

3D/2D Graphics Workstation

- **Wireframe Modeling**
- **4 Bit Planes, 8+8 Max**
- **16 Displayable Colors, 256 Max**

The 4335 introduces the 4330 Series 3D Graphics Workstations with Tektronix-quality graphics features and high-performance computing.

The 4330 Series operates with two 68020 processors working together to boost total applications performance. The applications processor operates at 20 MHz and is augmented by the 68881 floating point processor—and an optional floating point accelerator. An additional 68020 off-loads graphics processing from the CPU.

In addition to sharing the graphics features of the 4330/4230 Family, the 4335 offers extensive software compatibility, window management, and networking capabilities.

4336

3D/2D Graphics Workstation

- **Shaded Surface Images, Wireframe Modeling, Hidden Line Removal**
- **8 Bit Planes**
- **256 Displayable Colors**

The 4336 3D Graphics Workstation enhances display quality with 8 bit planes and 256 displayable colors.

Four more bit planes and a Z-buffer make the 4336 the entry-level workstation for applications requiring hidden line removal, translucency, and shaded surface rendering.

4337

3D/2D Graphics Workstation

- **True Color Display**
- **Shaded Surface Images, Wireframe Modeling, Hidden Line Removal**
- **12 Bit Planes, 24 Max**
- **4,096 Displayable Colors, 16.7M Max**

For the highest quality image rendering, the 4337 3D Graphics Workstation offers enhanced 4330/4230 performance. The 4337 comes with 12 bit planes, allowing the system to display 4,096 colors. It can be configured with up to 24 bit planes to provide true color—the ability to define displayable colors with 24 bits of precision and thus display 16.7 million shades. For smooth, dynamic movement, double-buffering is available on the 4337 by purchasing an additional 12-plane frame buffer.

NEW 4230 SERIES

3D/2D Graphics Terminals

Tektronix 4230 Terminals offer a series of 3D graphics terminals. Each of the three 4230 terminals shares the performance and quality display features described in the preceding paragraphs and in Table X. In addition, each terminal features some unique qualities to offer users the specific capabilities they require in graphics terminals. The differentiating features of each terminal are listed below.

4235

3D/2D Graphics Terminal

- **3D and 2D Wireframe Modeling**
- **4 Bit Planes, 8+8 Max**
- **16 Displayable Colors, 256 Max**

The 4235 3D Graphics Terminal provides an entry-level product in the 4330/4230 3D Family, offering high-performance 3D wireframe and expandability into other Family features. The 4230 Series operates with a 16.7 MHz 68020, and includes one RS-232C host port, two RS-232C peripheral interfaces, and color printer and LAN interfaces. Terminals come with 4M bytes of display memory, with an additional 20, 36, or 52M bytes optional.

A 4100F1U Field Upgrade Kit upgrades the 4235 Terminal to a fully-integrated 4335 3D Graphics Workstation.

4236

3D/2D Graphics Terminal

- **Hidden Line Removal and Local Shaded Surface Rendering**
- **3D and 2D Wireframe Modeling**
- **8 Bit Planes and 256 Displayable Colors**

The 4236 3D Graphics Terminal shares the performance of the 4235 Terminal and offers 8 bit planes and 256 displayable colors. Its enhanced graphics features include hidden line removal and shaded surface modeling.

A 4100F1U Upgrade Kit upgrades the 4236 Terminal to a 4336 3D Graphics Workstation.

4237

3D/2D Graphics Terminal

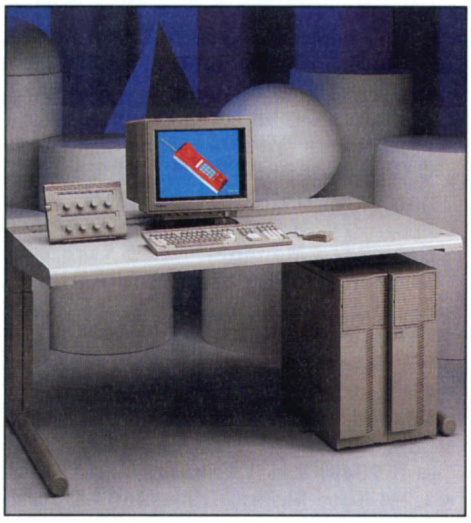
- **True Color Graphics**
- **12 Bit Planes, 24 Max**
- **4,096 Displayable Colors, 16.7M Optional**

The 4237 3D Color Graphics Terminal is Tek's highest-performance terminal. While it shares the 3D graphics performance of the rest of the 4230 Series, the 4237 is enhanced to offer 12 bit planes and 4,096 displayable colors. It can be configured with up to 24 bit planes, providing the ability to define displayable colors with 24 bits of precision and thus display 16.7 million shades.

A 4100F1U Upgrade Kit upgrades the 4237 Terminal to a 4337 3D Graphics Workstation.

For more information on the 4330/4230 3D/2D Graphics workstations and Terminals see Table 1.

Ordering information is on page 66.



4330 3D/2D Graphics Workstation.

NEW 4320/4220 FAMILY

2D Graphics Workstations and Terminals

- **Integrated Workstation or Host/Network-Connected Terminal Configurations**
- **20 MHz 68020 Workstation CPU, with 68881 Coprocessor and Optional Floating Point Accelerator**
- **16.0 MHz 68020/68881 Graphics Engine**
- **Pipelined Architecture and Custom Gate Arrays for Maximum Graphics Performance**
- **UNIX-Based UTek™ Operating System with System Administration Interface, On-Line Tutorials and On-Line Help**
- **256 Displayable Colors**
- **Tektronix Graphics Feature Set**
- **X Windows, Version 10.4**
- **C Compiler and IBM PC/XT Emulation, with Optional FORTRAN Compiler, Pascal Compiler, and UNIFY Data Base Manager**
- **Support for Ethernet, TCP/IP and Sun NFS***
- **4M Byte Display Memory, 8M Bytes Max**
- **4M Byte Workstation System Memory, Expandable to 12M Bytes**
- **86M Byte Hard Disk, 156M Bytes and 234M Bytes Optional**
- **1.2M Byte Floppy Disk, 360K Bytes Optional**

The Tektronix 4320 Series Graphics Workstations and 4220 Series Graphics Terminals deliver the advanced features and high performance needed to manipulate complex 2D graphics.

High-Performance Processing

The 4320/4220 Family offers excellent graphics price/performance. Motorola's 68020 16.0 MHz processor manages the display list, ASCII command processing, and input/output. Three microcoded engines, including a bit-sliced engine, accelerate graphics data manipulation. 4M bytes of graphics memory (3M bytes available to the user as display list memory) are standard, with an additional 4M bytes optional.

The 4320 Series Workstations operate with two 68020 processors working together to boost total applications performance. The applications processor operates at 20 MHz and is augmented by the 68881 floating point processor—and an optional floating point accelerator.

Tektronix' UTek Operating System is a powerful implementation of Berkeley 4.2 UNIX. With a number of extensions from System V, UTek facilitates system administration and maintenance.

Superior Graphics

The 4320/4220 Workstations and Terminals share outstanding graphics features. Graphics segments, combined with 32-bit virtual graphics coordinate space, allow full detail zoom and pan. Surfaces of one or more bit planes can be manipulated as layers, with user control over visibility. The scrolling dialog area keeps host communications, menus, and similar tasks separate from the graphics image, and user-definable markers can be used to create custom icons.

Software Compatibility

Tek's 4320/4220 Family is software-compatible with Tektronix 4120 Series Workstations and the new 4330/4230 Family of 3D Workstations and Terminals. This compatibility provides instant access to many software packages for tasks ranging from presentation graphics and drafting to cartographic analysis and mechanical design.

An industry-standard implementation of C is standard with the 4324 and 4325, and FORTRAN 77 and ISO Pascal are optional. IBM PC/XT software emulation is standard. Tektronix PLOT 10® TekniCAD™ and TekniCAP™ have been enhanced for the 4324.

Tektronix and Industry Standards

In addition to the Tektronix PLOT 10 graphics standards, 4320 Workstations implement UTek, Tektronix' powerful UNIX-based operating system. UTek's menu-based **sysadmin** interface simplifies the most complex system tasks, including network and system administration.

Networking is supported by an IEEE 802.3 Ethernet interface and the standard TCP/IP protocol. For file management across the network, the 4320 Series uses Sun Microsystems' Network File System (NFS)*.

Color Monitors

The 4320/4220 Family Workstations and Terminals offer a choice of color graphics monitors that display 256 colors from a palette of more than 16.7 million shades. Users can select 16-inch or 19-inch color displays, and choose either 1280×1024 addressability or 1024×768 addressability. Anti-reflective coating on the CRT screen cuts glare and the 60 Hz, non-interlaced operaton virtually eliminates flicker.

Colorful Hardcopy

A built-in color printer interface supports the Tektronix 4693D Color Image Printer and Tek's 4692 and 4696 Color Ink-Jet Printers. Print spooling allows system use while images are being printed.

* *Sun Microsystems' NFS will be available in Spring 1988.*

UTek, TekniCAD and TekniCAP are trademarks of Tektronix, Inc.
PLOT 10 is a registered trademark of Tektronix, Inc.

TABLE 2. 4320/4220 FAMILY PERFORMANCE CHARACTERISTICS

	4324 Workstation	4325 Workstation	4224 Terminal	4225 Terminal
System Processor	68020 @ 20 MHz 68881 coprocessor	68020 @ 20 MHz 68881 coprocessor		
Optional Accelerator	Floating point accel.	Floating point accel.		
Graphics Processor	68020 @ 16.0 MHz	68020 @ 16.0 MHz	68020 @ 16.0 MHz	68020 @ 16.0 MHz
Displayable Colors	256	256	256	256
Display Size Maximum Display Size	406 mm (16 in.) 483 mm (19 in.)	406 mm (16 in.) 483 mm (19 in.)	406 mm (16 in.) 483 mm (19 in.)	406 mm (16 in.) 483 mm (19 in.)
Addressability	1024×768	1280×1024	1024×768	1280×1024
System Memory (bytes) Maximum (bytes)	4M 12M	4M 12M		
Display Memory (bytes) Maximum (bytes)	4M 8M	4M 8M	4M 8M	4M 8M
Mass Storage (bytes)	86M hard disk, 1.2M flexible disk	86M hard disk, 1.2M flexible disk		
Optional Mass Storage (bytes)	156 or 234M hard disk, 60M cartridge tape, 360K flexible disk	156 or 234M hard disk, 60M cartridge tape, 360K flexible disk		
Interfaces	Dual RS-232C, LAN, Second RGB output, SCSI, Color printer	Dual RS-232C, LAN, Second RGB output, SCSI, Color printer	Host RS-232C, Dual RS-232C, LAN, Second RGB output, Color printer	Host RS-232C, Dual RS-232C, LAN, Second RGB output, Color printer
Optional Interfaces	Additional RS-232C	Additional RS-232C		
System Software	UTek, C, X Windows 10.4, PC software support	UTek, C, X Windows 10.4, PC software support		
Optional Software	Pascal, UNIFY, ACCELL	Pascal, UNIFY, ACCELL		
Supported GIN Devices	Thumbwheels, tablets, mouse, cursor pad	Thumbwheels, tablets, mouse, cursor pad	Thumbwheels, tablets, mouse, cursor pad	Thumbwheels, tablets, mouse, cursor pad
Supported Tek Color Printers	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D

The 4320/4220 Family Workstations and Terminals produce 2D color output with the Tektronix 4693D Color Image Printer.

NEW 4320 SERIES

2D Graphics Workstations

Tektronix provides a selection of 2D graphics workstations with quality performance and graphics capabilities. Both 4320 Workstations share the features of the 4320/4220 Family described in the preceding paragraphs and Table 2. In addition, each workstation has distinguishing features, offering the user a selection to meet specific graphics needs. Unique features of each workstation are listed in the following paragraphs.

4324

2D Graphics Workstation

- **1024×768 Addressability**

The 4324 Graphics Workstation introduces the Tektronix 4320 Series of fast, powerful graphics systems for integrated workstation environments. With Tek's UTek operating system to facilitate operations and maintenance, the 4324 has the power needed for mechanical design, cartography, and other graphics- and compute-intensive applications. With adherance to industry standards, the 4324 fits easily into a mixed-vendor computing environment.

4325

2D Graphics Workstation

- **1280×1024 Addressability**

The 4325 2D Graphics Workstation includes the features of the 4324, but adds higher, 1280×1024 addressability.

4224 2D Graphics Terminal with PLOT 10 TechniCAD.

NEW 4220 SERIES

2D Graphics Terminals

Tektronix introduces two 2D graphics terminals, both featuring the graphics performance of the 4320/4220 Family. To give the graphics user a selection, each terminal offers different display features, described in the following paragraphs.

4224

2D Graphics Terminal

- **1024×768 Addressability**

The 4224 2D Graphics Terminal provides the same performance and graphics qualities as the 4320/4220 Family. Dual RS-232C, LAN, and color printer interfaces make the 4224 suitable for host-based computing and environments with a network of hosts and workstations.

A 4100F1U Field Upgrade Kit easily upgrades the 4224 Terminal to a fully-integrated 4324 2D Graphics Workstation.

4225

2D Graphics Terminal

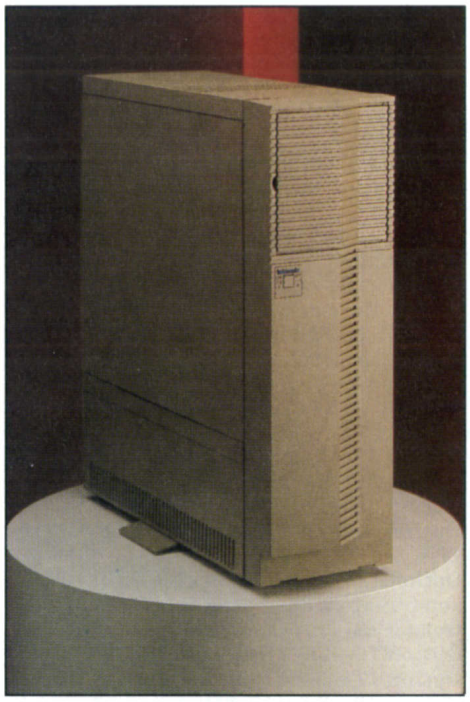
- **1280×1024 Addressability**

The 4225 2D Graphics Terminal enhances the features and performance of the 4224 Terminal. With addressability of 1280×1024, it improves 2D viewing of complex graphics images.

A 4100F1U Field Upgrade Kit upgrades the 4225 Terminal to a 4325 2D Graphics Workstation.

For more information on the 4320/4220 2D Graphics Workstations and Terminals see Table 2.

Ordering information is on page 66.



4301 Applications Processor.

The 4330/4230 Family Workstations and Terminals produce 3D color output with the Tektronix 4693D Color Image Printer.

NEW 4301

Applications Processor

- **20 MHz 68020 CPU, 68881 Floating Point Unit, Optional Floating Point Accelerator**
- **Tektronix UTek™ Operating System**
- **Integrated Ethernet Networking, with TCP/IP and Network File System**
- **Additional Computing for Tek 4120 Series Users**

A Workstation Compute Engine for Tektronix 4100 Series, 4120 Series and 4200 Series Terminals

The Tektronix 4301 Applications Processor provides local computing resources for Tektronix 4100, 4120 and 4200 Series terminals. The 4301 adds 2.5 MIPS of processing in a Unix-based operating system, local area networking, extensive mass storage, and broad-based software support.

High-Performance Engine

The 4301 bus architecture is built around a Motorola VMEbus, powered by a full 32-bit, 20 MHz 68020 and a 68881 floating point processor. An optional floating point accelerator provides even greater speed.

Tek's UTek operating system, an implementation of Berkeley 4.2 UNIX, offers a large command set with many System V extensions and advanced functions. With virtual memory of 256M bytes, UTek's interactive interface simplifies system administration and maintenance.

Programming and Software Support

A high-performance compiler for C is standard with the 4301, and a FORTRAN 77 compiler and ISO Pascal compiler are optional.

The 4301 supports Tektronix PLOT 10® TekniCAD™ and TekniCAP™. Software emulation for text-based IBM PC/XT applications is standard.

Networking

With a high-speed Ethernet local area network, the 4301 can connect to a network of Tektronix 4132 workstations, 4330 and 4320 workstations, 4230 and 4220 terminals, and other hosts and workstations. The Network File System and TCP/IP communications protocols expand networking capabilities.

Rapid Communications

The 4301 transfers data over a dual RS-232C port at rates of up to 38.4K bytes per second. The optional Interactive DMA Interface provides single-path communications at parallel speeds, and can be used with minimal programming for both bulk data and interactive transmissions to pass through a single channel.

PLOT 10 is a registered trademark of Tektronix, Inc. UTek, TekniCAD and TekniCAP are trademarks of Tektronix, Inc.

ORDERING INFORMATION

4330/4230 3D GRAPHICS WORKSTATIONS AND TERMINALS

4335 3D Graphics Workstation*1
Includes: Color display, tilt/swivel base, graphics module, compute module, VT 220-type keyboard, mouse, power cords, keyboard overlays, RGB cables, Operator Manual, Command Reference Manual, UTek Tools Manual, System Administration Guide, X Windows System Reference, NFS Reference*2, C User Manual, Workstation Master Index.
Optional Accessories: Service Manual, display calibration graticules, Software Porting Guide.
4336 3D/2D Graphics Workstation*1
Includes: Same as 4335.
4337 3D/2D Graphics Workstation*1
Includes: Same as 4335.
4235 3D/2D Graphics Terminal*1
Includes: Color display, tilt/swivel base, graphics module, VT 220-type keyboard, power cords, keyboard overlays, RGB cables, RS-232C cable, Operator Manual, Reference Manual, Introduction Brochure.
Optional Accessories: Service Manual, display calibration graticules.
4236 3D/2D Graphics Terminal*1
Includes: Same as 4235.
4237 3D/2D Graphics Terminal*1
Includes: Same as 4235.

4330/4230 FAMILY OPTIONS

Option 1A—(4330 Series Only) Floating Point Accelerator*1
Option 1B—(4330 Series Only) 4M byte Additional System Memory (8M bytes Total)*1
Option 1C—(4330 Series Only) 8M bytes Additional System Memory (12M bytes Total)*1
Option 2A—(4235/4335 Only) Additional 4 Bit Planes (8 Total)*1
Option 2E—(4237/4337 Only) 12 Bit Planes Double Buffered*1
Option 3A—(4330 Series Only) Dual RS-232C DMA*1
Option 3B—(4330 Series Only) Dual Centronics Interface*1
Option 3E—(4330 Series Only) Network Adapter*1
Option 3F—Interactive DMA for DEC DRV-11WA Interfaces*1
Option 3G—(4330 Series Only) Local Bus Adapter*1
Option 3W—Interactive DMA for DEC DR-11W Interfaces*1
Option 10—(4330 Series Only) Additional 360K byte Flexible Disk*1
Option 11—(4330 Series Only) Additional 360K byte Flexible Disk and Streamer Tape*1
Option 12—(4330 Series Only) Additional Streamer Tape*1
Option 16—(4330 Series Only) 156M byte Hard Disk*1
Option 17—(4330 Series Only) 234M byte Hard Disk*1
Option 32—19-inch 1280×1024 Color Display*1
Option 33—Stereoscopic Display*1
Option 49—Rental Tag*1

4320/4220 2D GRAPHICS WORKSTATIONS AND TERMINALS

4324 2D Graphics Workstation*1
Includes: Color display, tilt/swivel base, graphics module, compute module, VT220-type keyboard, mouse, power cords, keyboard overlays, RGB cables, Operator Manual, Command Reference Manual, UTek Tools Manual, System Administration Guide, X Windows Reference, NFS Reference*2, C User Manual, Workstation Master Index.
Optional Accessories: Service Manual, display calibration graticules, Software Porting Guide.
4325 2D Graphics Workstation*1
Includes: Same as 4324.
4224 2D Graphics Terminal*1
Includes: Color display, tilt/swivel base, graphics module, VT 220-type keyboard, mouse, power cords, keyboard overlays, RGB cables, RS-232C cable, Operator Manual, Command Reference Manual, Introduction Brochure.
Optional Accessories: Service Manual, display calibration graticules.
4225 2D Graphics Terminal*1
Includes: Same as 4224.

4320/4220 FAMILY OPTIONS

Option 1A—(4320 Series Only) Floating Point Accelerator*1
Option 1B—(4320 Series Only) 4M bytes Additional System Memory (8M bytes Total)*1
Option 1C—(4320 Series Only) 8M bytes Additional System Memory (12M bytes Total)*1
Option 3A—(4320 Series Only) Dual RS-232C DMA*1
Option 3B—(4320 Series Only) Dual Centronics Interface*1
Option 3E—(4320 Series Only) Network Adapter*1
Option 3G—(4320 Series Only) Local Bus Adapter*1
Option 10—(4320 Series Only) Additional 360K byte Flexible Disk*1
Option 11—(4320 Series Only) Additional 360K byte Flexible Disk and Streamer Tape*1
Option 12—(4320 Series Only) Additional Streamer Tape*1
Option 16—(4320 Series Only) 156M byte Hard Disk*1
Option 17—(4320 Series Only) 234M byte Hard Disk*1
Option 32—(4224/4324 Only) 19-inch 1024×768 Color Display*1
Option 32—(4225/4325 Only) 19-inch 1280×1024 Color Display*1
Option 49—Rental Tag*1

4301 APPLICATIONS PROCESSOR

Includes: Power cord, Installation Guide, Workstation User Guide, Command Reference, Tools Manual, System Administration Guide, NFS*2 Reference, C User Manual, Workstation Master Index.
Optional Accessories: Service Manual, Software Porting Guide.

OPTIONS

Option 1A—Floating Point Accelerator*1
Option 1B—Additional 4M byte System Memory*1
Option 1C—Additional 8M byte System Memory*1
Option 3A—Dual RS-232C DMA*1
Option 3B—Dual Centronics Interface*1
Option 3E—Network Adapter*1
Option 3F—Interactive DMA*1
Option 3G—Local Bus Adapter*1
Option 10—360K byte Flexible Disk*1
Option 11—360K byte Flexible Disk and Streamer Tape*1
Option 12—Streamer Tape*1
Option 16—156M byte Hard Disk*1
Option 17—234M byte Hard Disk*1
Option 49—Rental Tag*1

SOFTWARE PRODUCTS

4300P21 Data Base Manager*1
4300P22 ACCELL Integrated Development System*1
4300P37 FORTRAN 77 Compiler*1
4300P38 Pascal Compiler*1

SOFTWARE OPTIONS

01—Streamer tape media*1
02—1.2M byte flexible disk media*1

*1 *Contact your local sales office for information.*
*2 *Sun Microsystems' NFS will be available in Spring 1988.*

Field Upgrade Kits, international keyboards and international power cords are available. Contact your local Tektronix sales representative.

WARRANTY-PLUS SERVICE PLANS

See Customer Service.

RECONDITIONED TEKTRONIX INFORMATION DISPLAY PRODUCTS

- **Quick Delivery**
- **Low Prices**
- **New Product Warranties**
- **Quantity Discounts**

With Tek's quick delivery, you can be using Information Display products at substantial savings in just two weeks. Tektronix remanufactures demo and lease returns to latest specifications and offers them with new product warranties. Quantity discounts apply to current as well as discontinued products.

In the U.S., contact your local Tektronix Field Office for IDG Reconditioned Product availability and prices. Overseas customers call your Tektronix Sales Office.

NEW 4310 SERIES

Graphics Workstations

- **32-Bit 68020 CPU, 68881 Floating Point Processor**
- **Tektronix UTek™ Operating System**
- **Extensive Programming and Software Support, Including IBM PC Emulation**
- **X Windows with 4107 Graphics**
- **Choice of 13-inch Monochrome, 19-inch Grayscale, or 19-inch Color Displays**
- **Integrated Local Area Network**

The new Tektronix 4310 Series Graphics Workstations—the 4315, 4316 and 4317—bring together high-performance bit-mapped graphics, Tek's UTek operating system, an advanced set of programming languages, and software support for Tek 4107 and IBM PC applications. All three workstations are designed for computer-aided software engineering, 2D drafting, mapping, technical publishing, and other tasks.

Cost-Effective Performance

The 4310 Workstations are built around a 32-bit 68020 CPU and a 16.7 MHz 68881 floating point coprocessor, with a minimum of 4M bytes of RAM. They include integrated networking, an RS-232C port, and a Centronics-style parallel interface.

Each workstation includes a 1.2M byte flexible disk, an 86M byte hard disk, and a built-in SCSI to provide rapid disk input and output. With Ethernet and TCP/IP, the 4310 workstations support electronic mail, host communications, and peripheral sharing. All three workstations come with a three-button mouse and support Tek's new 4693D Color Image Printer and 4692 and 4696 Color Ink-Jet Printers.

UTek Power

Tek's UNIX-based UTek Operating System furnishes a comprehensive set of reliable utilities. Based on Berkeley 4.2bsd with a number of System V enhancements, UTek includes software development tools such as an enhanced **make** build control program, a version control system, and sophisticated queueing facilities. UTek's interactive interface simplifies system administration and maintenance.

Extensive Software

The 4310 Series Workstations come standard with a 68000 assembler, Green Hills Software's C compiler, and Tek's implementation of X Windows Version 10.4. To expand access to software, the 4310 Workstations can support Tektronix 4107 applications (via X Windows) and IBM PC/XT applications.

All three workstations support Tektronix PLOT 10® TekniCAD™ and several third-party software packages. The 4316 and 4317 support PLOT 10 TekniCAP™ also.

Smalltalk-80 and Other Advanced Languages

The 4310 Series provides Smalltalk-80 standard, enhanced by Tek with more than 500 additional classes of objects, an unlimited Large Object Space interpreter, grayscale and color integration into Smalltalk applications, and the ability to call functions and routines written in other languages. 4310 Workstation options include Green Hills' FORTRAN 77 and Pascal compilers, Tek Common LISP® , and QUINTUS PROLOG. Users have access to a large library of graphics routines and PLOT 10 Terminal Control System and Software Terminal Interface. Software developed for the Tektronix 4132, 4320 and 4330 Workstations is easily ported to the 4310 Series.

UTek, TekniCAD and TekniCAP are trademarks, and Tek Common LISP and PLOT 10 are registered trademarks, of Tektronix, Inc.

4310 SERIES PERFORMANCE CHARACTERISTICS

	4315	4316	4317
Processors	68020 @ 16.67 MHz 68881 coprocessor	68020 @ 16.67 MHz 68881 coprocessor Custom gate arrays	68020 @ 16.67 MHz 68881 coprocessor Custom gate arrays
Display Type	Monochrome	Grayscale (16 levels)	Color (16 from 4096)
Display Size	330 mm (13 in.)	483 mm (19 in.)	483 mm (19 n.)
Displayable Resolution	640×480	1376×1024	1376×1024
Addressability	1376×1024	1376×1024	1376×1024
System Memory (bytes)	5M	4M	4M
Optional Memory (bytes)	9 or 13M	8 or 12M	8 or 12M
Mass Storage (bytes)	86M hard disk 1.2M flexible disk	86M hard disk 1.2M flexible disk	86M hard disk 1.2M flexible disk
Optional Storage (bytes)	156 or 234M hard disk	156 or 234M hard disk	156 or 234M hard disk
Interfaces	RS-232C, LAN, SCSI, Centronics	RS-232C, LAN, SCSI, Centronics	RS-232C, LAN, SCSI, Centronics
Software	UTek, C, Smalltalk, X Windows 10.4, 4107 Virtual Terminal	UTek, C, Smalltalk, X Windows 10.4, 4107 Virtual Terminal	UTek, C, Smalltalk, X Windows 10.4, 4107 Virtual Terminal
Optional Software	Prolog, Common LISP, FORTRAN, Pascal	Prolog, Common LISP, FORTRAN, Pascal	Prolog, Common LISP, FORTRAN, Pascal
Supported Tek Printers	4692, 4696, 4693D	4692, 4696, 4693D	4692, 4696, 4693D

NEW 4315

Graphics Workstation

- **5M Byte System Memory, with 9 or 13M Bytes Optional**
- **1376×1024 Addressability, 640×480 Displayable Resolution**
- **Monochrome 13-Inch Display**
- **16.67 MHz 68020 Processor and 68881 Coprocessor**
- **UTek, C, Smalltalk and X Windows**

The Tektronix 4315 Graphics Workstation is a desktop workstation powered by a 16.67 MHz 68020 CPU and 68881 coprocessor. With the UTek Operating System, the 4315 provides tools for software development, an enhanced **make** build control program, the Revision Control System, and the Multiple-Device Queueing System.

The 4315's 640×480-pixel screen acts as a window into the 1376×1024 bitmapped display memory, effectively providing a much larger working area. To access the enlarged work space, a smooth panning feature automatically starts when the screen cursor reaches a display edge.

Advanced Languages and Software

The 4315 includes Tek's proprietary version of Smalltalk-80, enhanced to provide an even more efficient programming environment. FORTRAN 77 and Pascal compilers, Tek Common LISP, and QUINTUS PROLOG are optional with the 4315. It also runs Tek's PLOT 10 TekniCAD and a number of third-party software packages.

With 5M bytes of RAM, upgradeable to 13M bytes, the 4315 has an 86M byte hard disk and a 1.2M byte flexible disk. A three-button mouse aids input, and Tek's 4692, 4696, and 4693D printers are supported. For more information on 4310 Series performance characteristics, see page 67.

NEW 4316

Grayscale Graphics Workstation

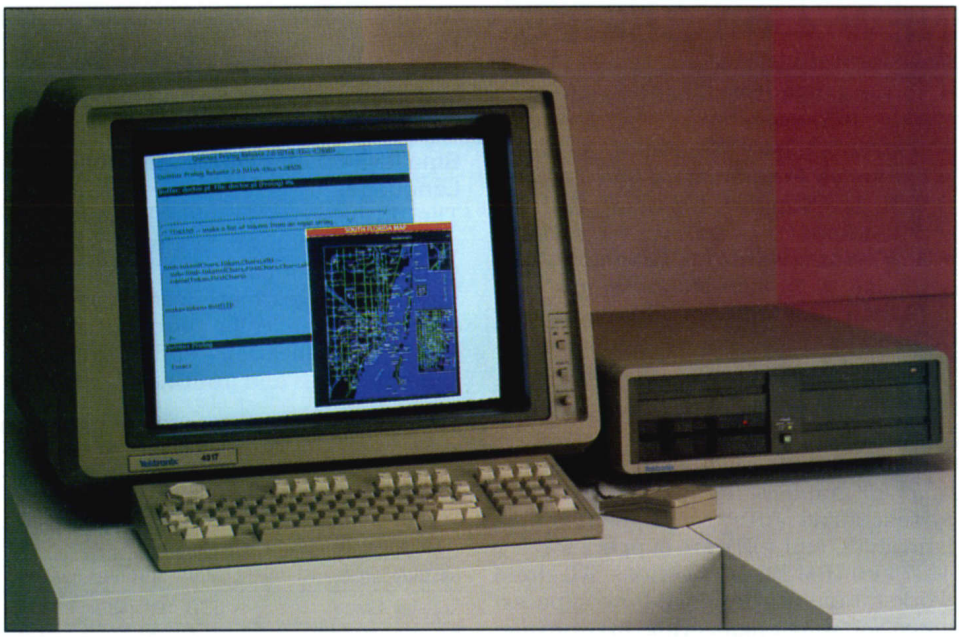
- **1376×1024 Addressability**
- **Grayscale 19-Inch Display**
- **4M Byte System Memory, with 8 or 12M Bytes Optional**
- **16.67 MHz 68020 Processor and 68881 Coprocessor, with Custom Gate Arrays**
- **UTek, C, Smalltalk and X Windows**

The Tektronix 4316 Graphics Workstation offers a 19-inch screen and 16 shades of gray. With 1376×1024 addressability and 10-mil spot size, the 70-Hz noninterlaced display has a flicker-free image. Proprietary gate array technology provides very fast grayscale BitBlt performance. This speed and resolution make the 4316 an excellent tool for technical publishing, grayscale imaging and vision system applications.

Programming and Software Support

The 4316 includes Tek's proprietary version of Smalltalk-80, enhanced to provide an even more efficient programming environment. To aid programmers, the 4316 offers as options FORTRAN 77 and Pascal compilers, Tek Common LISP, and QUINTUS PROLOG. It also supports Tektronix' PLOT 10 TekniCAD and TekniCAP.

With 4M bytes of RAM, upgradeable to 12M bytes, the 4316 has an 86M byte hard disk and 1.2M byte flexible disk. The 4316 supports Tektronix 4692 and 4696 Ink-Jet Printers and the new 4693D Color Image Printer. It comes with a 32×32-pixel, two-plane hardware cursor; a full-screen, cross-hair cursor; and a three-button mouse. For more information see 4310 Series performance characteristics on page 67.



4317 Color Graphics Workstation.

NEW 4317

Color Graphics Workstation

- **16 Colors From a Palette of 4096**
- **1376×1024 Addressability**
- **19-Inch Display**
- **4M Bytes System Memory, 8 or 12M Bytes Optional**
- **16.67 MHz 68020 Processor and 68881 Coprocessor, with Custom Gate Arrays**
- **UTek, C, Smalltalk and X Windows**

The Tektronix 4317 Graphics Workstation uses proprietary gate arrays to deliver outstanding color BitBlt performance. The 4317 displays 16 colors at once, selected from a palette of 4096 shades.

Programming and Software Support

The 4317 includes Tek's proprietary version of Smalltalk-80. FORTRAN 77 and Pascal compilers, Tek Common LISP, and QUINTUS PROLOG are available as options. The 4317 runs Tektronix' PLOT 10 TekniCAD and TekniCAP, as well as a number of third-party software packages.

The 4317 has 4M bytes of RAM, upgradeable to 12M bytes, an 86M byte hard disk and 1.2M byte flexible disk. The 4317 supports Tektronix 4692, 4696 and 4693D printers. It comes with a 32×32-pixel, two-plane hardware cursor; a full-screen, cross-hair cursor; and a three-button mouse. For more information see 4310 Series performance characteristics on page 67.

ORDERING INFORMATION

4315 Graphics Workstation*1
Includes: 68020 CPU, 68881 F.P., 5M byte RAM, 86M byte hard disk, 1.2M byte flexible disk, 13-in. monochrome display, 640×480 displayable resolution, Ethernet, RS-232 port, parallel port, 56M byte virtual address space, UTek O/S, Smalltalk-80, C, Assembler, IBM PC emulation, 4107 virtual terminal.
4316 Graphics Workstation*1
Includes: Same as 4315, except 4M byte RAM, 19-in. grayscale display, 1376×1024 displayable resolution, 6M byte virtual address.
4317 Graphics Workstation*1
Includes: Same as 4316, except with 19-in. color display.

OPTIONS

Option 05—(4315 Only) Additional 4M byte Memory (Total 9M bytes)*1
Option 05—(4316/4317 Only) Additional 4M byte Memory (Total 8M bytes)*1
Option 06—(4315 Only) Additional 8M byte Memory (Total 13M bytes)*1
Option 06—(4316/4317 Only) Additional 8M byte Memory (Total 12M bytes)*1
Option 23—156M byte Hard Disk (Replaces 86M byte Hard Disk)*1
Option 24—234M byte Hard Disk (Replaces 86M byte Hard Disk)*1
Option 4310F05—Field Installed 4M byte Daughter Board*1

SOFTWARE PRODUCTS

4300P21 Data Base Manager*1
4300P22 ACCELL Integrated Development System*1
4300P37 FORTRAN 77 Compiler*1
4300P38 Pascal Compiler*1

SOFTWARE OPTIONS

Option 01—Streamer tape media*1
Option 02—1.2M byte flexible disk media*1

*1 *Contact your local sales office for information.*

International Power Plug Options Are Available.

***WARRANTY-PLUS* SERVICE PLANS**
See Customer Service.

SMALLTALK-80

- **Extensible, Object-Oriented Programming**
- **Bit-Mapped Graphics User Interface**
- **Designed for Exploratory Programming**

Smalltalk-80 combines an object-oriented programming language with the most advanced user interface available. Pioneered at Xerox PARC, Smalltalk-80 permits exploratory programming through rapid prototyping and experimentation. Smalltalk-80 provides an interactive approach to solving complex problems.

High-Performance Implementation

Tektronix' implementation of Smalltalk-80, combined with the powerful hardware architecture of the 4300 Series, provides graphic response fast enough to support screen animation under direct control of Smalltalk-80.

Smalltalk-80 satisfies the needs of advanced software developers in the field of artificial intelligence and is ideal for AI research and development. Smalltalk-80 can be extended by defining new instances of an object class (each with its own internal state) or by defining an entirely new object class with a distinct set of rules and default behavior. The class structure of Smalltalk-80 provides both multiple inheritance and hierarchical inheritance mechanisms. Over 200 predefined classes support the data and control abstractions most commonly used in AI applications development.

Original Windowing System

Bit-mapped graphics and window management were originally developed for Smalltalk-80. The Smalltalk-80 Model-View-Controller window-based manager supports the creation of new window-based applications. Multiple processes are supported with a virtually unlimited number of overlapping windows.

Smalltalk-80 supports primitive graphics functions such as scaling, translation, rotation, logical combination of pixels, and text attribute modification, through its integral "BitBlt" operator.

Any activity—text editing, file manipulation, compilation, execution, debugging—can be performed, regardless of the current state. The user simply "opens" another window and proceeds with the new operation. Smalltalk-80 allows immediate access to any of its subsystems, whether user-defined or predefined, for inspection or modification.

TEK Common LISP®

- **A Full Common LISP Implementation**
- **Optimized for 4300 Systems**
- **Rapid Prototyping of AI Concepts**
- **Run Time Compiler for Optimized Machine Code**

TEK Common LISP® has been specifically optimized and enhanced for the Tektronix 4300 Series. It provides AI researchers and software developers with a personal LISP programming environment previously available only on dedicated LISP machines.

Common LISP was conceived by a large committee of academicians and AI researchers as a language that would incorporate the very best features of other LISP dialects. Tek Common LISP is a full implementation of this language (as specified in "Common LISP, the Language" by Guy Steele). It offers a much richer set of data types and more complex program structures than other LISP dialects currently in use.

A New Standard

Common LISP is considered by many artificial intelligence experts to be a new industry standard for AI programming environments. This consensus is reflected in the general parameters established for the language.

Commonality: Common LISP focuses the features of several different implementations of LISP into a common dialect.
Portability: Applications written in Common LISP are easily ported to any Common LISP implementation.
Expressiveness: Common LISP is a very rich language that employs the most valuable constructs from other LISP dialects.
Efficiency: Common LISP has features designed to facilitate the production of fast, high-quality compiled code.
Compatibility: Since Common LISP is derived from a number of popular dialects, code from other LISP dialects should readily map into Common LISP.

Additional Tek Common LISP Features
Additional features include a powerful optimizing compiler with built-in debugging features; lexically-scoped interpreter and compiler; full-featured package system for symbol name differentiation; rich collection of numerical primitives and built-in functions; built-in garbage collector and dynamic storage management; complete implementation of arrays, vectors, and strings; flexible interactive user interface; flexible debugging aids; powerful facilities for structures and macros; lexical closures; built-in user-extensible data-type facility; and built-in user-extensible parser and hash-table facility.

The rich set of primitives available in Common LISP makes the language an appropriate candidate for expert systems, natural-language interfaces, and all types of symbolic programming. Tek Common LISP goes beyond the specifications of the language to provide on-line documentation, a user-definable error handler, powerful and robust foreign function interfaces to C and FORTRAN programs, and a built-in Flavors system for object-oriented programming.

TEK Common LISP is a registered trademark of Tektronix, Inc.

QUINTUS PROLOG

- **Configured for 4300 Series Systems**
- **Non-Procedural Language for Rapid Development**
- **Modularity for Less Complexity**

QUINTUS PROLOG, as implemented for the Tektronix 4300 Workstations, is a unique language that allows programmers to solve problems by specifying answers needed rather than describing a detailed solution procedure. Based entirely on facts and logical relationships or rules, PROLOG is one of the acknowledged languages in artificial intelligence. PROLOG allows programmers to concentrate on the problem/solution without the confusion of computer-constrained procedures.

PROLOG operates on the principle of "controlled deduction." The programmer creates a network of facts and rules that describes the known relationships between the elements of a problem. Once the logical network is defined, PROLOG makes logical inferences from the relationships when queried by the programmer. These features make PROLOG ideal for many AI applications including expert systems, natural-language processing, data base-query languages, and automatic programming systems.

Language and AI Environment for Productivity

QUINTUS PROLOG simplifies complex problems and reduces program development time. Program development is integrated with an EMACS editor, allowing interactive editing and debugging. And programs can call other languages to create a full AI environment. Predicate definitions and programs can be edited, loaded, and then tested immediately with the PROLOG Interpreter. PROLOG modules are developed individually and then integrated with other modules into an application. Once they are debugged, the modules can be compiled to create highly efficient executable code.

Performance for Complex Problems

The inherent efficiency of QUINTUS PROLOG is enhanced by the power of the Tek 4300 Series hardware. With compiled QUINTUS PROLOG code more than 70,000 logical inferences per second are possible on the 4300 Series. When combined with the 4300 Series, QUINTUS PROLOG is an ideal vehicle for both advanced software development and end-user AI applications.

ORDERING INFORMATION

4300P32 EMACS Editor*1
4300P33 TEK Common LISP*1
4300P36 QUINTUS PROLOG*1

OPTIONS

Option 01—Streamer Tape*1
Option 02—1.2M byte Flexible Disk*1

*1 *Contact your local sales office for information.*

4944

Mass Storage Unit

- **Compatible with Tektronix 4300 Graphics Workstations**
- **Removable 45 or 60M Byte Streamer Tape**
- **Standard SCSI Interface**
- **86, 90, 156 and 234M Byte Hard Disks**

To satisfy a variety of customer requirements, the 4944 Mass Storage Unit offers a flexible combination of streamer tape, hard disk and floppy disk drives.

Options

- Four 86-, 90-, 156-, and 234-M byte high-performance, Winchester disk drives, with seek time of less than 30 microseconds and track-to-track access time of less than 6 microseconds.
- 4944 streamer tape drive operating at 90 inches per second and transferring data at a maximum rate of 86.7K bytes per second, making it ideal for quick back-up and restoring information stored on hard disks.

4944 options have been tailored for use with the Tektronix workstations.

ORDERING INFORMATION

4944 Mass Storage Unit — **$1,000**
Includes: Power cord (161-0066-00); two meter SCSI cable (012-1117-00); Instruction Manual (070-5978-00); SCSI terminator (011-0090-00).

OPTIONS (4300, 6130, 4132 Series)
Requires UTek O/S

Option 11—60M byte streamer tape — **+$2,500**
Option 12—90M byte disk — **+$5,500**
Option 15—60M byte streamer tape +90M byte disk — **+$8,000**
Option 16—156M byte disk — **+$7,500**
Option 17—60M byte tape +156M byte disk — **+$10,000**
Option 18—234M byte disk — **+$10,000**
Option 19—60M byte tape +234M byte disk — **+$12,500**

OPTIONS (4400 Series)
Requires Uniflex O/S

Option 01—60M byte streamer tape — **+$1,750**
Option 02—90M byte disk*1
Option 03—60M byte streamer tape +90M byte disk — **+$5,250**

OPTIONS (4120 Series)

Option 21—45M byte disk*1
Option 22—45M byte disk + dual floppies*1

FIELD INSTALLED KITS

4944F01—60M byte streamer tape — **$2,750**
4944F02—90M byte fixed hard disk — **$5,750**
4944F03—86M byte fixed hard disk — **$5,750**
4944F04—156M byte fixed hard disk — **$7,750**
4944F05—234M byte fixed hard disk — **$10,250**

INTERNATIONAL POWER PLUG OPTIONS

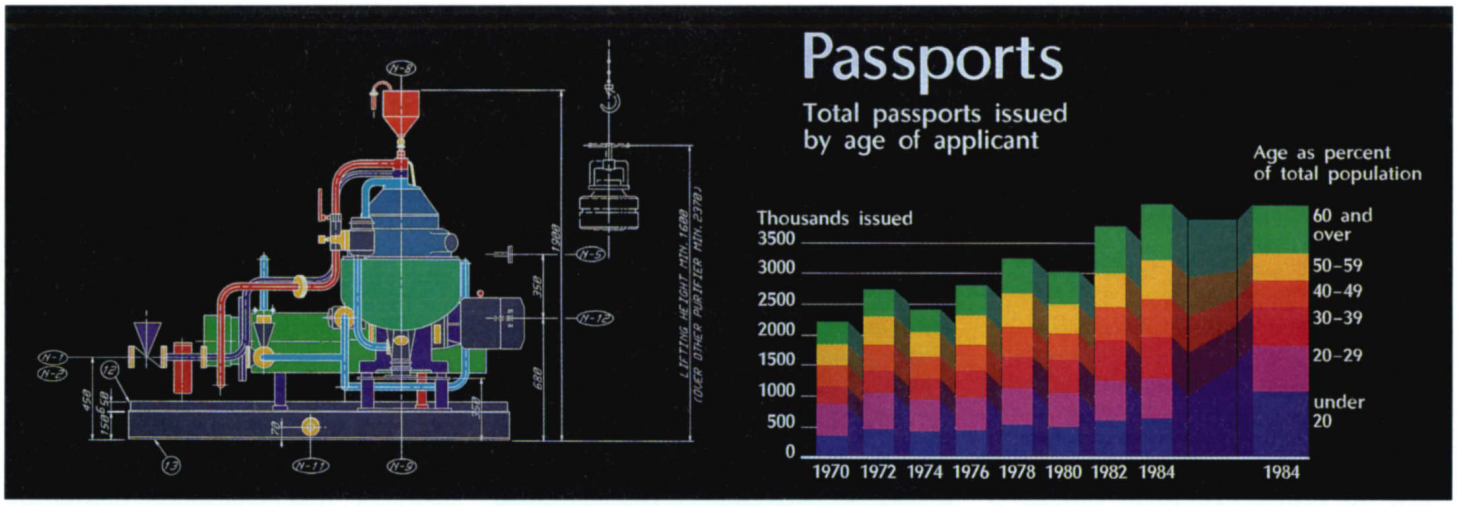
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

*1 *Contact your local sales office for information.*

OPTIONAL ACCESSORIES

SCSI Cables—
25 inch, 4944 to 4944 or 4926 or 61TC01. Order 012-1178-00 — **$155**
2 m, 4944 to 4400 or 4120. Order 012-1117-00 — **$70**
2 m, 4944 to 4132/6130. Order 012-1146-00 — **$140**
SCSI Interface—For 4132/6130. Order 61KP04 — **$800**
DC600A Tape Cartridge—
Order 119-1463-01 — **$285**

PLOT 10® APPLICATIONS SOFTWARE AND STANDARD TOOLS



PLOT 10® TekniCAD™.

PLOT 10® TekniCAP™.

PLOT 10® TEKNICAD™

- **Bill of Material Report Generation**
- **User-Definable Macros for System Customization**
- **Semiautomatic Creation of Additional Isometric or Orthographic Views**
- **Calculation of Area, Perimeter, Centroid, Moments of Inertia, and Area and Volumes of Revolution**
- **Automatic Clipping of Drawing Items Underlying an Inserted Symbol**
- **Dual English/Metric Dimensioning**

PLOT 10 TekniCAD is a computer-aided drafting application for the production and maintenance of engineering drawings. The TekniCAD user interactively creates a drawing composed of geometry (points, lines, and arcs), symbols (such as a geometric tolerance symbol), dimensions, and annotation (notes, arrows, and crosshatching). Use of TekniCAD does not require extensive training or knowledge of complex command languages.

PLOT 10 CADDPORT

PLOT 10 CADDPort is a data exchange utility allowing Tektronix PLOT 10 TekniCAD to share drawing information with other applications. CADDPort supports ANSI Initial Graphics Exchange Specification (IGES), Intergraph Standard Interchange Format (SIF), AutoCAD Drawing Exchange File (DXF), PDA Engineering PATRAN, APT, and COMPACT-II file formats.

PLOT 10 TEKNICAP™

- **Creates Line, Bar, and Pie Graphs from Keyboard-Entered Data or Extracted Data**
- **Prepares Formatted Text Slides with Bulleted or Numbered Items**
- **Produces Illustrations and Graphic Designs**
- **Combines Multiple TekniCAP Generated Graphics into Single Visuals**
- **Schedules Production of Full-Color TekniCAP Visuals on Paper, Overhead Transparency, or 35 mm, 4×5, or 8×10 in. Film**

PLOT 10 TekniCAP is an application for the production of high-quality color graphics for technical and business presentations. The menu system and predefined formats within TekniCAP make it easy to create graphs, text slides and illustrations.

TekniCAP also features the ability to include graphic images created by another application and combine them with TekniCAP-generated visuals to reinforce a message or present graphics from a variety of sources in a consistent form. The images can be modified within TekniCAP with the addition of annotation or graphics, scale and rotation, or alteration of color.

PLOT 10 TEKPLOT

PLOT 10 TekPlot, a drawing output utility, is a companion product to Tektronix PLOT 10 TekniCAD, PLOT 10 GKS, and PLOT 10 IGL. Drawings and graphics produced by these PLOT 10 products can be output through TekPlot on industry-standard plotters from Benson, Bruning (ZETA), CalComp, Hewlett-Packard, Houston Instrument, IBM and Versatec.

PLOT 10 GSI

PLOT 10 GSI is the software interface between IBM mainframe computers and the Tektronix Color Graphics Systems. GSI creates presentation-quality color hardcopies from IBM GDDM graphics. Independent of the terminal, GSI spools the graphics to Tektronix CX4692S or CX4696S Color Output Systems.

Through GSI, users can enhance GDDM drawings with up to 256 colors, change line widths, and modify the background color when processing the file. Other features can be included when GSI is installed.

GSI can use any ADMGDF output file, including those produced by PLOT 10 IGL, PLOT 10 GKS and The Interactive Chart Utility (ICU).

GSI provides the user with a variety of interface methods. On IBM with MVS/TSO, the GSI interface choices are: JCL, CLIST, or ISPF/PDF. On IBM with VM/CMS, the choices are EXEC or ISPF/PDF.

PLOT 10 is a registered trademark of Tektronix, Inc. TekniCAD and TekniCAP are trademarks of Tektronix, Inc.

NEW PLOT 10® PHIGS

PLOT 10 PHIGS is a library of subroutines for software developers, based on the Programmer's Hierarchical Interactive Graphics System (PHIGS) proposed as an American National Standard for Information Systems.

PLOT 10 PHIGS is used by an applications programmer to develop interactive 3D and 2D graphics applications. The hierarchical data structure simplifies creation and manipulation of complex 3D and 2D graphics. For increased flexibility and the most efficient use of computer resources, PLOT 10 PHIGS can be programmed in either FORTRAN or C.

PLOT 10 PHIGS extensions provide a uniform method for accessing device-dependent functions like local transformations and arc generation. When used with the Tektronix 4300 Series Graphics Workstations, PLOT 10 PHIGS increases applications speed.

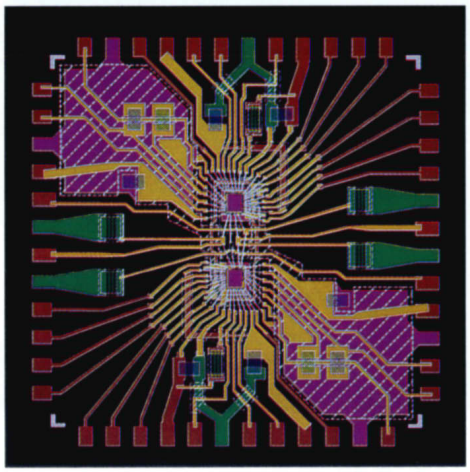
PLOT 10® STI.

PLOT 10 STI

PLOT 10 STI is a high-speed, high-performance graphics software tool for building 3D and 2D applications. STI provides complete and direct access to all the features built into the full range of Tektronix terminals and workstations.

There is a one-to-one correspondence between the terminal features and the user-callable routines in the STI library. The programmer can write C or FORTRAN applications utilizing the full capabilities of the equipment. STI includes support for internal picture processor access and the interactive DMA interface.

STI runs in many host and workstation environments, including Tek workstations, VAX, MicroVAX, IBM mainframes, IBM PC/RT and a generic UNIX implementation.



PLOT 10® GKS.

PLOT 10 GKS

PLOT 10 GKS is a FORTRAN 77 graphics subroutine library that features host and device-independent 2D graphics, and program portability to other GKS implementations. PLOT 10 GKS is a certified implementation of the Graphical Kernel System level 2b as specified by the International Standards Organization (ISO) and the American National Standards Institute (ANSI).

PLOT 10 GKS is a solid base for building data analysis, CAD/CAM, and other applications. GKS supports a wide variety of terminals, plotters, and hardcopy devices, and includes a Model Device Driver for implementing additional device support.

GKS takes advantage of precompiled libraries, optimized for installation on a host computer in minutes. GKS is supported on many different host computer platforms, including Tektronix workstations, VAX, MicroVAX, IBM mainframes, IBM PC/RT and a generic UNIX implementation. For hosts not directly supported, GKS includes the Model Universal Input/Output (UIO) routines.

PLOT 10 IGL

PLOT 10 IGL is a device-independent implementation of the ACM/SIGGRAPH Core proposal for a graphics software development tool.

IGL has a wide range of advanced features, such as line smoothing for curved lines, graphics segment control, and three-dimensional support for text and graphics. IGL supports a full range of terminals, plotters, and hardcopy devices, and includes a Model Device Driver for implementing support for other devices.

IGL takes advantage of precompiled libraries, optimized to install on a host computer in minutes. IGL is supported on many different host computer platforms including Tektronix workstations, VAX, MicroVAX, IBM mainframes, IBM PC/RT and a generic UNIX implementation. For hosts not directly supported, IGL includes the Model Universal Input/Output (UIO) routines.

Advanced Graphing II (AGII) is an IGL option providing a higher-level layer of subroutines for producing graphs.

PLOT 10 TCS

PLOT 10 TCS is a software development tool for the graphics application builder. TCS provides a basic graphics command set comparable to the feature set of Tektronix 4010 Series products.

TCS supports non-4010 Series terminals and workstations in 4010 emulation mode. For increased performance with contemporary Tek products, the enhanced device drivers feature picture processor opcode and interactive DMA interface support. Support for other devices can be added with the model device driver.

TCS can be installed as a FORTRAN 77 and/or 66 subroutine library, on many different host computer platforms including Tektronix workstations, VAX, MicroVAX, IBM mainframes, IBM PC/RT and a generic UNIX implementation.

TCS also includes Advanced Graphing II (AGII), a higher-level layer of subroutines for producing graphs.

PLOT 10 is a registered trademark of Tektronix, Inc.

Tek 4696 Color Ink-Jet Printer (left), 4692 Color Graphics Copier (center), and 4693D Color Image Printer.

TEKTRONIX COLOR OUTPUT SOLUTIONS

The Tektronix 4690 Series Ink-Jet Printers offer high-quality output on paper or transparency material. The 4696 is a personal printer for producing screen copies or plots. The 4692 Color Graphics Copier handles higher-volume printing applications.

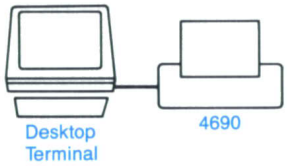
The 4510A Rasterizer enhances 4690 Series quality and speed, while making it possible to connect the 4692 and 4696 directly to a host computer or other data source. The 4510A, in conjunction with the 4690 Series, forms cost-effective color output systems with considerable configuration flexibility.

A New Technology in Printing

Tek introduces a new technology in its 4693 line of high-quality color graphics printers. The 4693 printers increase quality and throughput while holding the line on cost with thermal wax transfer color printing.

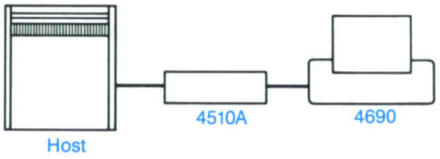
The 4693D Color Image Printer offers more than 16 million reproducible colors at fast speeds. The 4693DS bundles 4693 technology with the 4510A Color Rasterizer for highest resolution printing.

Screen Copying



The 4690 printers can attach directly as screen copiers to Tek color display terminals/workstations. Screen copying is a simple, cost-effective way to produce hardcopy. No additional printer hardware or software is required to drive attached printers. The terminal acts as a printer/controller, minimizing impact on the host and eliminating the need for printer drive software.

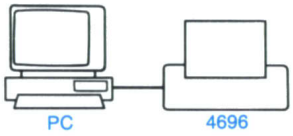
Shared Resources



The 4510A Rasterizer connects 4690 Printers directly to host computers via standard RS-232C interfaces. All system users can share high-quality color output while freeing the terminals during output. The CX4510A brings the same capability to users in IBM 3270 environments.

The 4690 Series connection to a host is supported by host-based graphics application software packages. This connection provides the color output at maximum resolution and color selection.

Direct Host Connection



The 4690 printers use an 8-bit parallel interface to connect directly to host computers for certain applications. For example, the 4696 Color Ink-Jet Printer is compatible with a large number of graphics applications that run on PCs. The connection is a cost-effective method of producing excellent quality color output from leading PC software packages.

Configuration Flexibility

Many simultaneous 4510A and 4690 Series combinations are possible, providing maximum flexibility to configure color output systems which match application demands.

NEW 4693D

Color Image Printer

- **Accepts Full Color Graphics of Up to 2048×1536 Pixel Resolution**
- **Reproduces More than 16 Million Colors or 256 Shades of Gray**
- **Color or Monochrome Printing at One Minute per Page**
- **300 dpi Thermal Wax Transfer Technology**
- **Handles Multiple Users and Applications Simultaneously**

The 4693D Color Image Printer features a high-speed digital interface, a Motorola 68020-based controller, and a 300-dpi color thermal wax print engine. In as little as 1.5 minutes the 4693D can accept and print high-resolution graphics images on paper or transparencies.

With a color palette of more than 16 million colors, the 4693D excels at high-quality printing of computer-generated color graphics from 2D line drawings and business graphics to sophisticated computer imaging. Even at resolutions of 2048×1536 pixels with full 24 bits-per-pixel color depth, the 4693D maintains its quality. The 4693D also can accept a color image and print it in black and white, using up to 256 shades of gray. With an optional 4-channel multiplexer and optional memory, the 4693D queues and processes multiple images simultaneously, providing optimal results to each user without delay.

The 4693D features compatibility with a full line of Tektronix color display systems and workstations as well as many non-Tek vendors, including Apollo and Sun.

Ordering Information is on page 76.

4696

Color Ink-Jet Printer

- **Includes Screen Copy Utility for IBM PC**
- **Support From Many PC Applications**
- **Three High-Quality Graphics Modes**
- **Easy Installation and Maintenance**
- **Roll, Sheet or Transparency Capability**
- **Quiet, 0.47 Square Inch-Per-Second Printing**
- **Complete Supplies Start-Up Kit**

The 4696 Color Ink-Jet Printer combines low cost, excellent image quality, and quiet performance in a compact design. It produces vivid color graphics with addressability of up to 120×240 dots per inch.

Inks, specially formulated for the 4696, provide excellent color saturation and brilliance. A separate black cartridge ensures a true black that is unobtainable from other systems that mix dyes. Three graphics printing modes offer a variety of print qualities and speeds, including enhanced black at regular speed and enhancement of all colors at reduced speed.

The 4696 provides users of Tektronix color terminals with high-quality color screen copies at the push of a single key. IBM PC users get the same capability with the free color screen copy software included with each 4696.

The 4696 includes start-up supplies and an interface cable for Tek terminals or, as an option, for PCs.

Ordering Information is on page 76.

4692

Color Graphics Copier

- **Superior Image Quality and Excellent Color Saturation**
- **Unique Ink-Transient Suppressor for Reliable Operation**
- **Adjustable for A and A4 Sizes**
- **Horizontal and Vertical Formats**
- **Four-Channel Multiplexer I/F Option**
- **Variable Image Density and Copy Time**
- **216 On-Board Colors**
- **Complete Supplies Start-Up Kit**
- **Auto-Handling of Paper and Transparencies**

The 4692 Color Graphics Copier represents a standard in color ink-jet reliability. The high-performance, air-assist, drop-on-demand technology provides resolution of up to 1536×1152 dots in an A-size image. Specially matched paper and transparency media and inks provide highly saturated colors, including vivid black.

CHARACTERISTICS

Addressability—Fixed-mode vertical and horizontal: 6 dots/mm (154 dots/in.). Variable "preview" mode vertical and horizontal: 128 to 158 dots/in.

Print Time—1-2 min. (Total data and transmission time is dependent on image complexity and host driver.)

Page and Image Format—A and A4 output sizes. Landscape and portrait format selectable under program control.

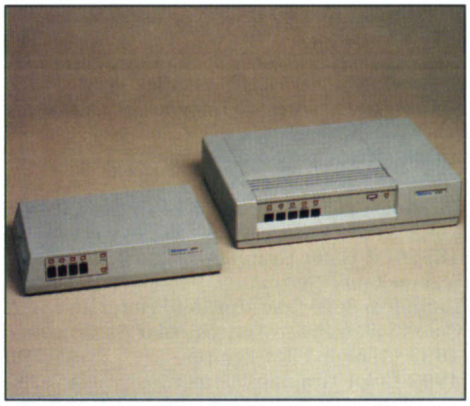
Image Sizes—Variable depending on orientation and image source (for A size output; A4 size slightly smaller to maintain adequate margins).

Compatibility—Tektronix 4104A/5A/6A/7A/9A/11/CX, 4205/7/8/9/CX, 4113B/15B Option 19, Tektronix Color Graphics Workstations, PC-4100, 4510A/CX Color Graphics Rasterizer, Sun and Apollo workstation environments.

Interface—Eight-bit parallel.

Data Rate—Up to 400 Kbytes (burst mode).

Ordering Information is on page 76.



NEW 4521/4522

Color Video Processors

- **Color Screen Copy Capability for Terminals, Workstations, and Monitors with Color Video Outputs**
- **RGB Video Input**
- **Image Capture in 2 Seconds for Fast Display Off-load**
- **Multiple Image Queuing and Print Requests**
- **8 or 64 Colors**
- **Compatible with Tektronix 4692, 4696, or 4695 Color Printers**

The 4521 and 4522 Color Video Processors provide a simple method of interfacing Tektronix color ink-jet printers to a variety of terminals, workstations and monitors.

The 4521 or 4522 Color Video Processor quickly captures a copy of the display video signal, freeing the display for other tasks. It converts the screen image into data for use by a Tek 4692, 4696, or 4695 Color Printer to produce a copy of the screen image. The 4521 and 4522 also produce multiple copies of a single image, as well as multiple image capturing and queuing. (Screen resolution may affect multiple image queuing capability.)

Three to five BNC cables connect the source terminal and the Color Video Processor. A menu-prompted setup and calibration process directs installation.

The 4521 and 4522 are easily connected to the Tek 4111 Series and 4109 Color Graphics Terminals. They are compatible with the DEC VT241 and the Chromatics CGC 7900. Other terminals and workstations that have red, green, blue (RGB), and sync video outputs may be compatible.

Ordering Information is on page 76.

NEW 4690SC

Color Graphics Screen Copier Systems

- **8 or 64 Colors**
- **Wide Compatibility with Tektronix and Other Popular Color Terminals and Monitors**
- **Analog RGB Video Interface**
- **No Special Software or Printer Drivers Required**
- **Image Queuing and Multiple Copies**

The 4690SC Color Graphics Screen Copier Series renders hard copies of color display screen graphics for CAD technical drawings, business graphs, graphic arts, statistical plots, cartography, medical, and other images.

Tektronix offers selection of the 4696 Color Ink-Jet Printer (for the 4696SC Systems) or the superior quality 4692 Color Graphics Copier (for the 4692SC Systems), for use with a choice of the Tek 4521 or 4522 Color Video Processors.

The 4690SC captures color images from the video display screen in 2 seconds, freeing the terminal or workstation for added productivity.

With the 4692 Color Graphics Copier, the System produces deep-density color transparencies approximately 4 minutes after the image is captured, and paper copies in approximately 3 minutes. The 4692SC Systems also offer automatic sheet media handling.

With the 4696 Color Ink-Jet Printer, the System provides copies on paper or transparencies approximately 3 minutes after the image is captured.

The 4690SC Series interfaces to many terminals and workstations via RGB video ports. It is plug-compatible with Tektronix 4109 Series and 4111 Color Graphics Terminals, depending on applications. The 4690SC also is compatible with other terminals such as the DEC VT 241, the Chromatics CGC 7900, and many others.

Ordering Information is on page 76.

4510A

Color Graphics Rasterizer

- **Provides Maximum-Resolution Output to Tektronix 4690 Color Printers**
- **A Shared System Resource**
- **More Than 130,000 Colors Available**
- **Available With IBM 3287-Style Coaxial Interface (CX4510A)**
- **Compatible With Tektronix 4100, 4200, 4110, and 4120 Series Color Graphics Terminals (2D Vector Data)**
- **Available as a Bundled System With Tek 4692, 4696 or 4693D Color Printers**

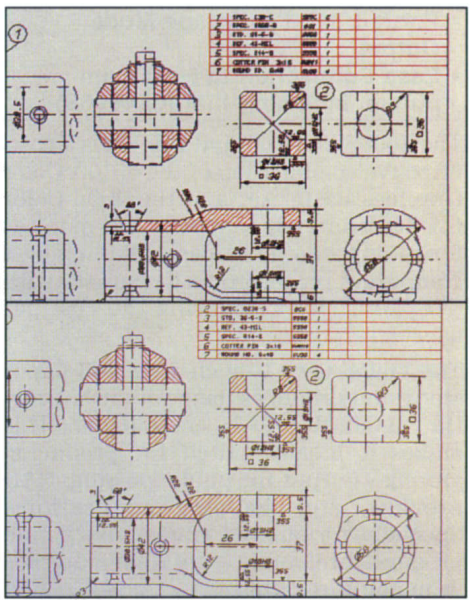
The 4510A Color Graphics Rasterizer facilitates a direct host connection of the 4691, 4692, 4695, and 4696 color graphics printers, creating shared system resources. It also can connect to most Tektronix color terminals to form high-resolution color output systems.

The 4510A accepts Tektronix-style graphics data serially and drives an attached color graphics printer at its maximum potential for color and resolution. Even complex images are clear and jagged lines smooth when processed by the 4510A.

When equipped with the optional IBM-style coaxial interface, the 4510A can be connected simultaneously to an IBM and a non-IBM host computer.

The 4510A is supported by leading host-based graphics software packages.

Ordering information is on page 76.



Graphics printing with (top) and without (bottom) the Tektronix 4510A Rasterizer.

4692S

Color Output System

- **Cost-Effective Bundling of the 4510A and 4692 Color Graphics Copier**
- **Fast, High-Quality Color Output in A and A4 Sizes**
- **Available With IBM Coaxial Interface (CX4692S)**
- **Shared Resource for Host-Based Graphics Applications**

The 4692S Color Output System produces brilliant, high-resolution color copies on paper or transparency material. Its four-channel RS-232 interface connects to multiple data sources simultaneously, including host computers and Tektronix graphics display terminals.

The 4692S uses pre-cut paper and transparency media. In combination with its large-capacity ink cartridges, it can be shared by a number of users with minimal operator attendance.

The CX4692S combines all the benefits of the 4692S, replacing two of the serial input ports with an IBM compatible coaxial interface. Two serial ports are available for simultaneous connection to non-IBM hosts or Tektronix terminals.

4696S

Color Output System

- **Includes 4510A Rasterizer and 4696 Color Ink-Jet Printer**
- **Brilliant Color Plots in 3 Minutes**
- **Image Area Up to 8.5×11.4 Inch**
- **Portrait and Landscape Mode Output**
- **Easy Connection to Host Computers, Including IBM (CX4696S)**

The 4696S Color Output System is a cost-effective combination of the 4510A Color Graphics Rasterizer and the 4696 Color Ink-Jet Printer. It connects to as many as four RS-232 data sources, including host computers or Tektronix terminals with peripheral ports, reducing the cost per user.

The 4696S uses 10-inch wide roll paper stock and produces images that entirely fill standard 8.5×11 inch paper. This makes it ideally suited for producing graphics output for public posting, CAD preview, and mapping applications. Specially formulated transparency film produces brilliant presentation materials in moderate volumes.

The CX4696S offers a simple connection to IBM 3274 cluster controllers.

NEW 4693DS

Color Output System

- **Cost-Effective Bundling of the Tek 4510A Rasterizer and the NEW 4693D Color Image Printer**
- **300 dpi Color Output on A and A4 Paper Sizes**
- **Excellent Transparency Quality**
- **IBM 3270 Coax Option**

The 4693DS Color Output System combines the NEW 4693D Color Image Printer with the Tek 4510A Color Rasterizer. The 4693DS provides color output at the same resolution found on most laser printers.

The 4693DS can be enhanced with additional printer and rasterizer memory, allowing the system to perform printing and rasterization, and receive data simultaneously for maximum throughput. It can convert color image data to monochrome gray scale images for faster throughput and higher quality photocopies.

With its reliable, automatic paper handling capability and high-speed throughput, the 4693DS is an effective shared resource. The 4693DS is compatible with Tektronix and other leading computer systems, and with the IBM 3270 through the CX option.

ORDERING INFORMATION

4693D Color Image Printer **$7,995**
Includes: 4M byte RAM and a Tektronix 8-bit parallel port.

4521/4522 Color Video Processors **$1,995**
Includes: Instruction Manual, power cord, three 75-Ω BNC cables.

4692SC1 Color Graphics Screencopier System **$8,995**
Includes: 4692 Color Graphics Copier and 4521 Color Video Processor; 8-color system.
(The 4692SC1 must be ordered with Option S0. See Customer Service.)

4692SC2 Color Graphics Screencopier System **$9,995**
Includes: 4692 Color Graphics Copier and 4522 Color Video Processor; 64-color system.
(The 4692SC2 must be ordered with Option S0. See Customer Service.)

4696SC1 Color Graphics Screencopier System **$2,995**
Includes: 4696 Color Ink-Jet Printer and 4521 Color Video Processor; 8-color system.

4696SC2 Color Graphics Screencopier System **$4,995**
Includes: 4696 Color Ink-Jet Printer and 4522 Color Video Processor; 64-color System.

4696 Color Ink-Jet Printer **$1,795**

4692 Color Graphics Copier **$7,795**
The 4692 must be ordered with on-site installation and setup.

4510A Color Graphics Rasterizer **$5,995**
4692S Color Output System **$12,995**
4696S Color Output System **$6,995**
4693DS Color Output System **$12,995**

OPTIONS

Option 01—Set-up for A4 metric size output **NC**
Option 02—4-channel multiplexer **+$2,500**
Option 04—(4696) Substitute PC printer cable for the standard interface cable **NC**
Option 32—(4510A, 4692S, 4696S, CX4692S, CX4696S) 2M bytes memory total **+$1,995**
Option 34—(4693D) 4M bytes additional memory **+$2,500**
Option 34—(4693DS) 4M bytes additional memory plus 1.5M bytes additional memory for the 4510A **+$2,500**
Option 38—(4693D) 8M bytes additional memory **+$4,000**
Option 38—(4693DS) 8M bytes additional memory plus 1.5M bytes additional memory for the 4510A **+$4,000**
Option 42—(4693D) Sun w/s driver; includes hardware and software **+$2,200**
Option 49—(4693D, 4693DS, 4693RGB) Rental tag **NC**
Option CX—(4693DS) Substitute the CX4510A for the 4510A **+$2,000**
Option 1A—(4692S, 4696S, 4693DS) PLOT 10 GSI Software, MVS/TSO (for IBM system environments only) **+$2,000**
Option 1C—(4692S, 4696S, 4693DS) PLOT 10 GSI Software, VM/CMS (for IBM system environments only) **+$2,000**

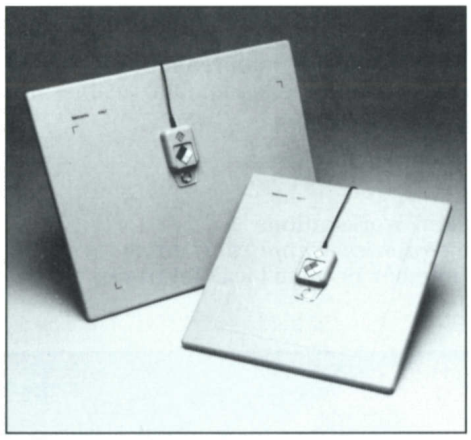
INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Customer Service.

Flexible leasing programs available in the continental U.S.



4957

Graphics Tablet

- **Graphics Input Capabilities for 4100A, 4110, 4120 and 4200 Color Graphics Terminals, Tektronix Graphics Workstations and RS-232C-Based Computers**

To use the 4957 Graphics Tablet, merely touch the four-button cursor-puck or stylus (optional accessory) to the tablet's active area. The tablet calculates the coordinates and relays them to the host computer for storage or manipulation.

The 4957 can augment a terminal keyboard as a menu selection device, move a cursor around a display screen, or help transfer data from paper to a computerized data base.

The 4957 is compatible with the Tektronix 4106A, 4107A, 4109A, 4110A, 4120 and 4200 Series Color Graphics Terminals and Tektronix Graphics Workstations.

CHARACTERISTICS

Size—419×394 mm (16.5×15.5 in.).
Active Writing Area—297×297 mm (11.7×11.7 in.).
Resolution—User-selectable up to 1000 points/inch.
Speed—User-selectable up to 90 coordinates/second.
Accuracy—±0.625 mm (0.025 in.).
Repeatability—±0.250 mm (0.010 in.).
Maximum specs may not be accessible from all terminals.

ORDERING INFORMATION

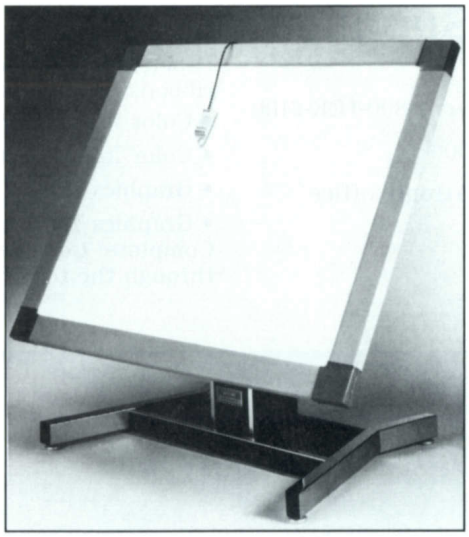
4957 Graphics Tablet **$995**
Includes: Power supply and cord (119-1748-00); four-button cursor (119-1775-00); Operator Manual (070-4784-01).

OPTION

Option 02—305×456 mm size (12×18 in.) **+$700**

***WARRANTY-PLUS* SERVICE PLANS**

See Customer Service.



4958

Graphics Tablet

- **Highly Precise, Easy-to-Use Graphic Input Capabilities for 4110, 4120, and 4200 Color Graphics Terminals, Tektronix Graphics Workstations and RS-232-Based Computers**

The 4958 Graphics Tablet is available in either 17×24 inch desktop, 36×48 inch pedestal-compatible, or 44×60 inch pedestal-compatible configurations. The 4900H01 Tablet Pedestal is available for pedestal-compatible surfaces.

The 4958 reads graphic coordinate data via a multi-button cursor or a stylus (optional). When either is touched to the tablet surface, the tablet calculates the coordinates and relays them to the host computer/terminal for further processing.

The tablet cursor is available with 4 or 16 buttons, with a fine cross-hair lens for accurate point selection. The cursor serves as a programmable hand-held keyboard from which the user can perform user-defined functions.

The 4958 offers up to 1,000-points-per-inch resolution with 0.010-inch accuracy.

ORDERING INFORMATION

4958 Graphics Tablet
Includes: Power supply and cord (119-1748-00); four-button cursor (119-1775-01); and User Manual.

OPTIONS

Option 03—(17×24 in.) **+$4,000**
Option 05—(36×48 in.) **+$6,450**
Option 06—(44×60 in.) **+$8,750**
4900H01 Tablet Pedestal **$1,500**
Includes: Power cord and data sheet (062-8975-00).

***WARRANTY-PLUS* SERVICE PLANS**

See Customer Service.

4991S1

Graphic Input Workstation

- **Five-Fold Productivity Increase Over Manual Digitizing or On-Screen Redesign**
- **Transfers Hard Copy Into CAD Systems**
- **Automatic Scanning and Vectorizing**

The 4991S1 Graphic Input Workstation quickly and accurately transforms existing documents into a useful data base for CAD systems. It supports many applications in mechanical engineering, architecture, mapping, and electrical engineering.

The 4991S1 interfaces directly to three leading CAD systems. The direct interface ensures rapid, accurate data transfer. Because scanning and structuring processes are performed locally, CAD system resources are not tied up with time consuming input tasks.

The interactive Graphic Structuring Software gives the user maximum flexibility and control in preparing the most usable data base for any given application. The structuring software supports a variety of entities (lines, arcs, text, symbols), standard attributes (line width, line style), and user-definable attributes.

A straightforward user interface simplifies scanning and structuring by allowing the operator to control most functions from on-screen menus, using the graphics tablet and stylus.

ORDERING INFORMATION

4991S1 Graphic Input Workstation **$146,800**

OPTIONS

Contact your local Tektronix Sales Representative.

***WARRANTY-PLUS* SERVICE PLANS**

See Customer Service.

International Power Plug Options are available.

Computer Graphics Supplies

To order graphics supplies,
call the Direct Order Desk toll-free number: 1-800-TEK-6100

Alaska & Oregon call collect: 0-503-642-8000

International customers call your local Tektronix office

Open from 6:00 am to 5:00 pm PST

VISA/MasterCard accepted

Papers, pens, transparencies, ink and maintenance cartridges, ribbons, toners, diskettes, data cartridges, manuals, cables for:

- Color Image Printers and Systems
- Color Ink-Jet Printers and Systems
- Graphics Tablets
- Graphics Terminals and Workstations

Complete *Computer Graphics Supplies Catalog* available through the toll-free number or your local Tektronix office.

AnthroCart™

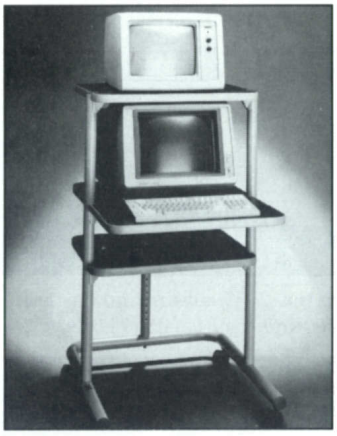
The AnthroCart is mobile, compact, and rugged. You can move and share your equipment, plus stack your hardware in only 5-½ sq. ft. of space. And you can feel confident that your equipment is safely supported, because the AnthroCart holds up to 150 lbs. on its heavy duty steel frame.

AnthroCart Compact PC with options, including Printer Basket option and Slide-Out shelf option.

AnthroCart Compact PC with options, including SideCar option.

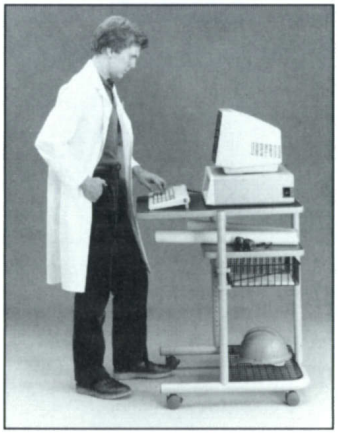
AnthroCart Compact GT with Options, including Printer Basket option.

AnthroCart Full-Size GT with Extension Shelf Kit option.

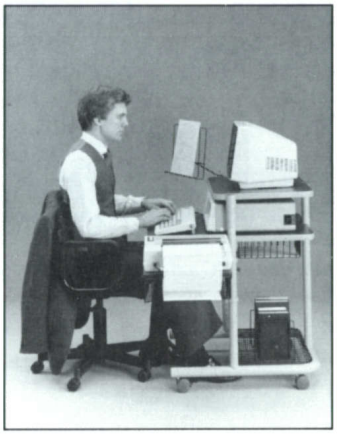


AnthroCart Compact GT with Extension Shelf Kit option.

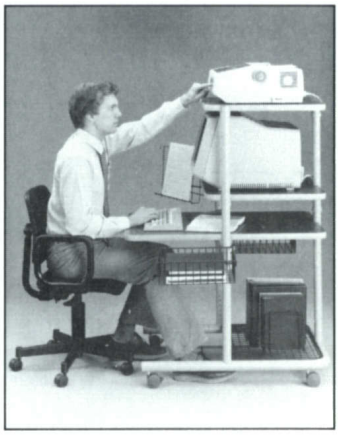
AnthroCart Compact 4×4 GT with options.



The AnthroCart configured for a stand-up application.



The AnthroCart meets ergonomic requirements.



The AnthroCart keeps everything within arms reach.

ANTHRO™

ANTHRO CORPORATION
Technology Furniture
3221 N.W. Yeon St.
Portland, OR 97210
TWX (910) 333-6481

For more information on the AnthroCart call:
Outside Oregon: **1-800-325-3841**
In Oregon: (503) 241-7113

Anthro is a trademark of Anthro Corporation, a subsidiary of Tektronix, Inc.

AnthroArm PC

- **Holds up to 60 lbs.**
- **Easily Adjusts Up and Down**
- **Safely Tilts and Swivels**
- **Simple to Attach and Use**

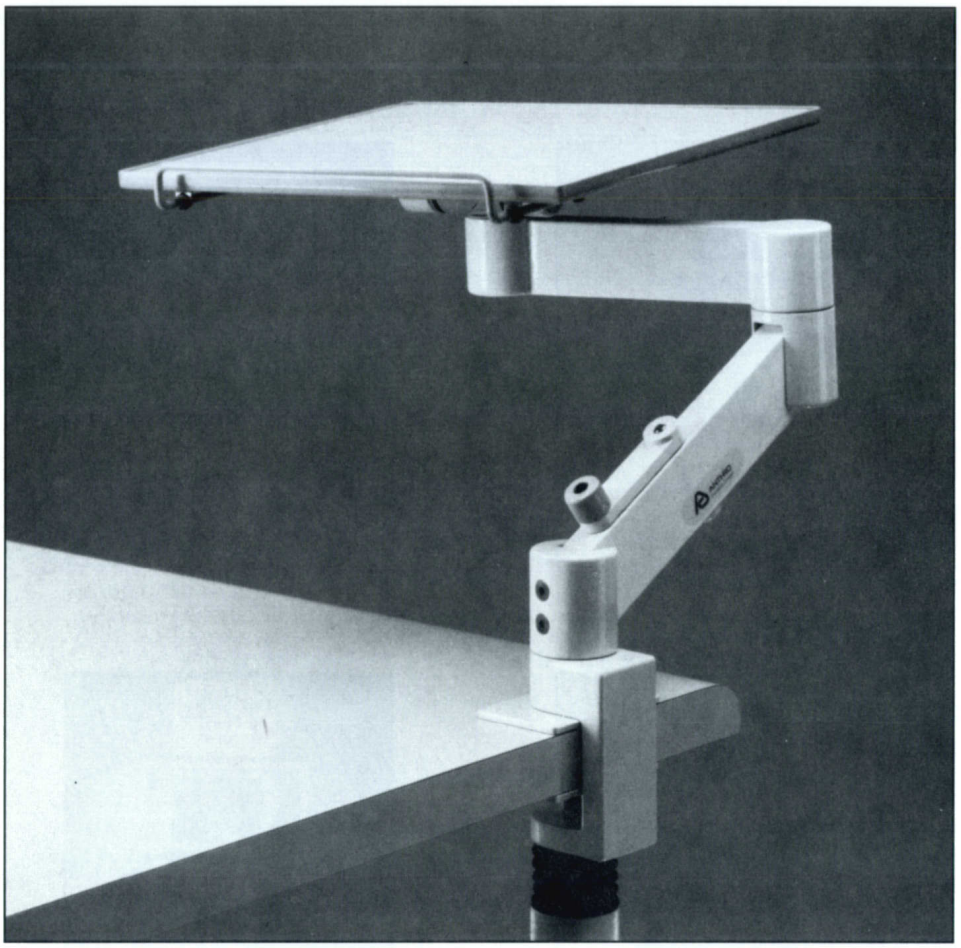
The AnthroArm PC frees your desk space. You can keep your screen within easy reach or share your monitor with others. Move it up, down or swivel it around so you're perfectly comfortable.

The AnthroArm PC is the armature that positions your monitor exactly where you want it:

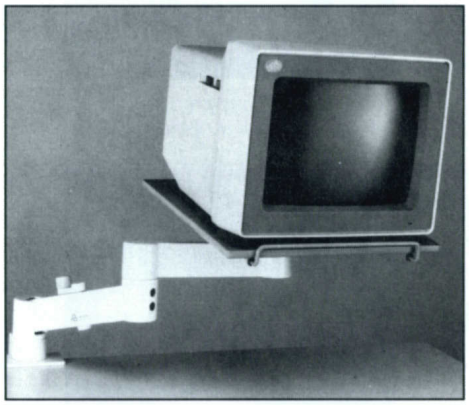
- Raise your monitor 8½ to 13¼ inches above your desk for eye level viewing.
- Extend the AnthroArm 16½ inches to bring it near you, or retract the arm to move it out of the way.
- Swing the AnthroArm 360° and easily tilt it ±15° so your screen is at the best angle.

Made of casted hardened aluminum, the arm moves easily up and down using a specially designed screw/tilt mechanism. Each arm is hand built and safely holds up to 60 lbs. The AnthroArm PC has a 12×12-inch nonskid grey platform which tilts using friction action. The arm also has a durable baked-on powder-coated, off-white finish.

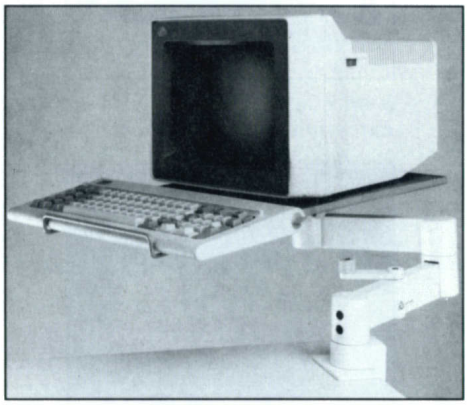
For more information on the AnthroArm PC call:
Outside Oregon: **1-800-325-3841**
In Oregon: (503) 241-7113



AnthroArm PC keyboard holder optional. Also available with 17×17" platform.



The AnthroArm PC extends or retracts for convient use.



The AnthroArm PC moves up or down with the simple turn of a handle.

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AnthroArm™ GT

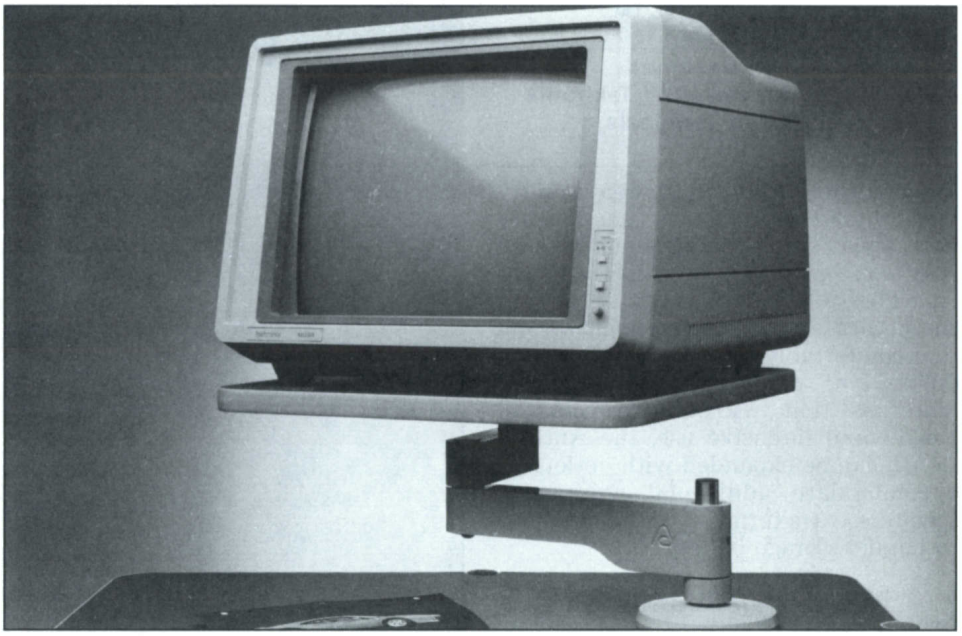
- **Holds up to 200 lbs.**
- **Rotates 360°**
- **Cast Aluminum Construction**
- **Five Year Warranty**

The AnthroArm GT is the space saving armature designed to hold substantial loads—up to 200 lbs. Float your heavy 19 inch terminal above your workspace and have plenty of room to spread out underneath.

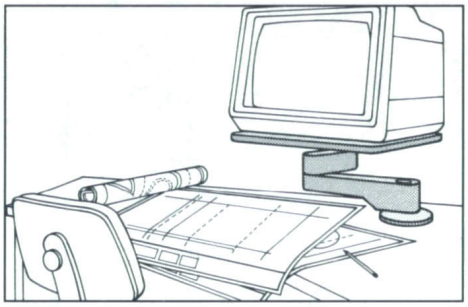
Now you can easily move your terminal around. Push the AnthroArm back to store your monitor out of the way. Pull it towards you for better viewing. Swivel it 360° to get rid of screen glare, to see your terminal if you're on the phone, or to share with others.

Choose between three different models, depending on the reach you want (how much depth you have on your work surface) and how high you want your terminal (the compound arm raises your terminal higher than the single arms).

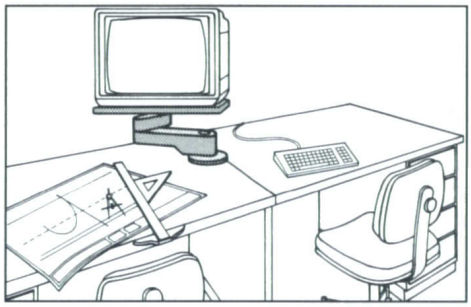
The AnthroArm GT. The only arm strong enough to give you back your workspace.



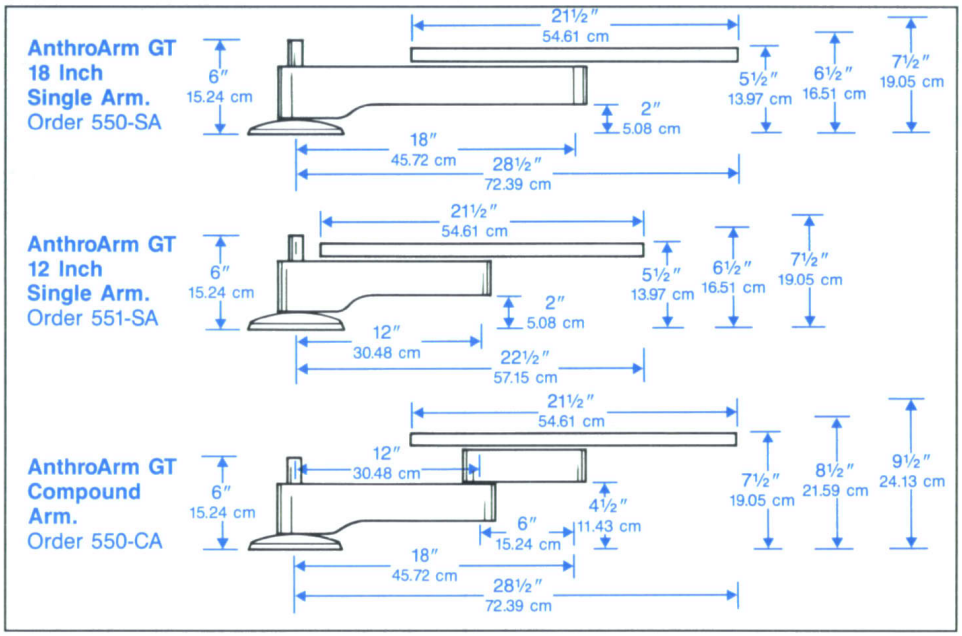
AnthroArm GT is also available with tilt option and AnthroArm GT with 13×13 inch platform.



The AnthroArm clears your work surface so you have more space.



With the AnthroArm, you can share terminals between stations.



CHARACTERISTICS

- Arm, base plate and mounting plate are thick-wall aviation grade casted aluminum, hardened to T6. The parts have a baked-on powder coated smoke tan finish.
- The main pivots are 1 inch ID brass bushings. Other pivots are oil light brass bushings.
- The 45 lb. density, 21½×21½ inch shelf is 1 inch thick with vinyl t-molding edges. The surface is high pressure laminate with non-skid pads for additional safety.
- Two stacking lugs (7/8 inch each) are included for height adjustment.

For more information on AnthroArm GT call:
Outside Oregon: **1-800-325-3841**
In Oregon: (503) 241-7113

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AnthroBench™

- **The Workbench Designed Specifically for the NEW Tektronix Workstations and Terminals**
- **Five-Year Warranty**

The AnthroBench is a heavy duty workbench that combines functionality with style. The modular bench uses an easy telescopic action to adjust the height from 25 to 29 inches. The center track on the surface is a cable management system that comfortably holds surge protectors, cords and cables. Constructed of materials that withstand substantial weight and intensive use, the AnthroBench can be expanded with options to accommodate additional equipment (printers, extra terminals or monitors) or to handle storage issues.

PHYSICAL CHARACTERISTICS

Overall Width—60 inches.
Overall Depth—36 inches.
Height—Adjustable from 25 to 29 inches.
Cable Management Track—2.3 inches wide by 4.25 inches deep.
Weight—110 lbs.
Color—Smoke Tan/Light Grey.
Shipping—Requires assembly.

UNIT CONSTRUCTION

Cross Beam/Supports/Base—Fabricated steel with powder coated finish.
Legs—3×6 inch aluminum extrusion with powder coated finish.
Connecting Joints— Cast aluminum.
Top—Wood honeycomb structure with high pressure laminate with rolled edges.

For more information on the AnthroBench call:
Outside Oregon: **1-800-325-3841**
In Oregon: (503) 241-7113

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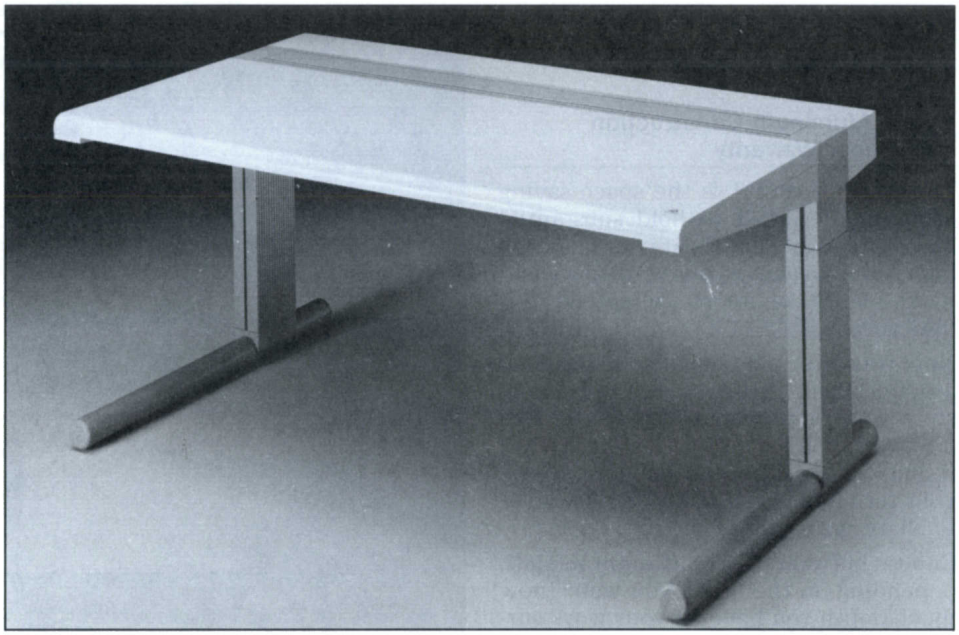
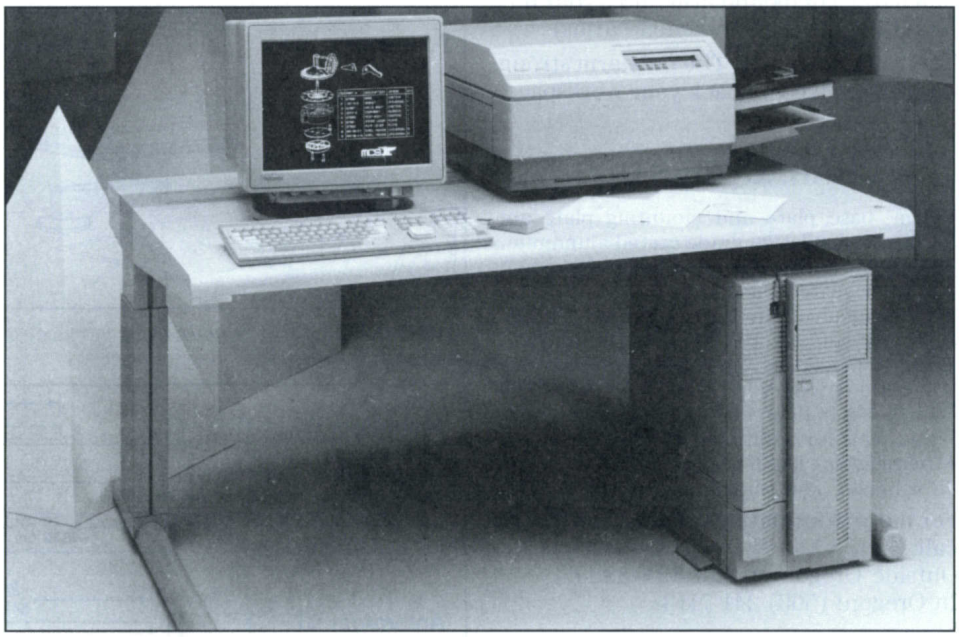
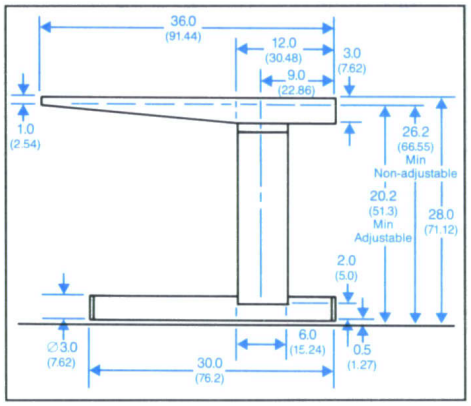


The AnthroBench combines good design with functionality.



The AnthroBench easily supports heavy hardware.



DESIGN AUTOMATION PRODUCTS

CONTENTS

Computer Aided Engineering 84
Computer Aided Software Engineering 91
Logic Analyzers 103
Semiconductor Test Systems 134

Tektronix Design Automation products provide a comprehensive array of tools intended for engineering, production, and service applications throughout the electronics industry. As the electronics industry demands ever-increasing front-end design automation via computer-aided processes, Tektronix' Design automation tools respond with computer-aided software engineering systems and with test and measurement linkages to CAE and CASE Systems. In applications ranging from VLSI prototype verification and computer servicing, to microcomputer software development, to production semiconductor testing, products from the Design Automation Group have set the industry standard for versatility, innovativeness, and performance.

Computer-Aided Engineering

Tektronix believes the solution for higher productivity and investment protection in electronics engineering can be achieved through the Tektronix Aided Engineering (TAE) approach to design automation. TAE provides a complete, integrated, modular electronic design system that supports the entire design cycle from concept to production. It leverages the productivity of engineering teams through networking and distributed database management.

Computer-Aided Software Engineering

Tektronix is committed to providing solutions for the emerging CASE market-place—a logical fit for our expertise, TekCASE's goal is to provide a functional and integrated tool set for software design engineers—software, life-cycle management from concept to completion to maintenance. TekCASE products meet the needs of software engineers in both private industry and government markets.

These design solutions are integrated in TekCASE's life-cycle software tools automate the transformation from one software development phase to another. Current key products include TekCASE Analyst, TekCASE Designer, TekCASE Auditor and Language Development Systems, V-Systems, and a Multi-V System. To support the analysis and design phases of the software life-cycle, TekCASE tools are available in the most common computer environments.

Logic Analyzers

The Logic Analyzer Division provides instrumentation for testing and measuring digital hardware and software throughout the entire cycle of design, manufacture, and service. This instrumentation includes data acquisition, pattern generation and data analysis.

The breadth and modularity of the Logic Analyzer product line ensures powerful, cost-effective solutions for applications ranging from testing VLSI devices to troubleshooting failing equipment remotely over telephone lines.

Semiconductor Test Systems

With the introduction of the LT-1000 VLSI Logic Test System, Tektronix Semiconductor Test Systems Division initiates a new era of cost-effective testing of high-speed, high-pin-count VLSI circuits. This system was developed specifically to meet the demands of testing CMOS application-specific devices (ASICs).

Tektronix provides the hardware, software, training, and applications-engineering support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources, not as insurmountable problems. At Tektronix, we've built on our past experience and knowledge about device testing and tester design to create products that can help you meet your testing challenges—today and in the future.

CONTENTS

Designer's WorkSystem 85
PCB WorkSystem 86
Gate Array WorkSystem 87
Full Custom WorkSystem 88
Signal-Processing WorkSystem ... 89
MERLYN-P Layout Tool 90
MERLYN-G Layout Tool 90
MERLYN-S Layout Tool 90
Customer Support Services 90

TEKTRONIX AIDED ENGINEERING

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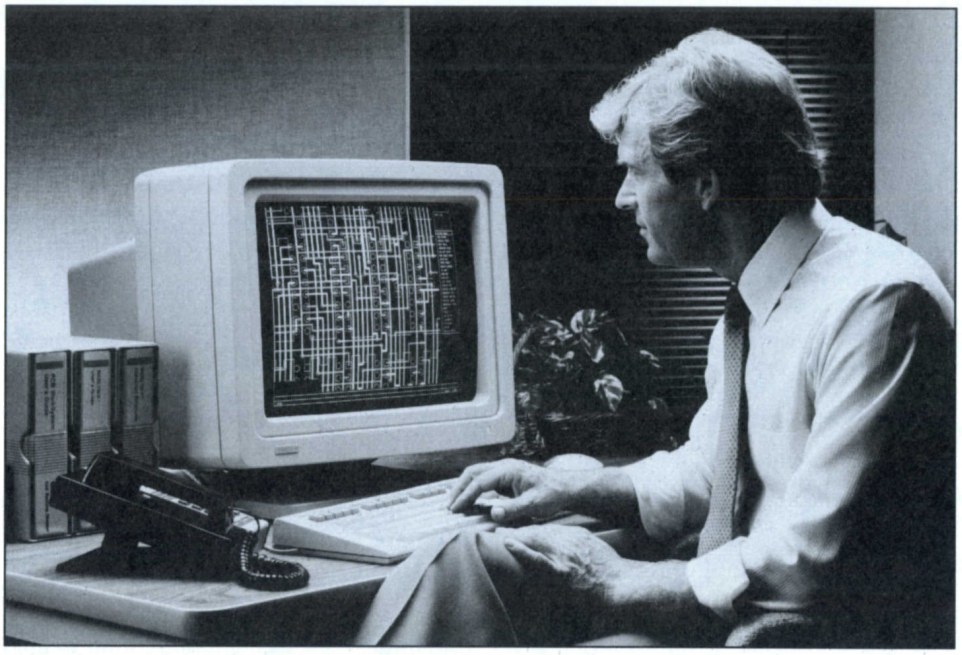
EXPANDING BEYOND CAE SOLUTIONS

Tektronix implements its TAE approach through WorkSystem products. A WorkSystem is a collection of design automation tools brought together to solve a particular design problem, such as printed circuit board or gate array design. WorkSystem tools come from Tektronix' CAE Systems, Logic Analyzer and CASE product divisions.

- TAE provides the core CAE products including design capture, documentation, simulation and layout, all supported by extensive libraries.
- TAE provides products with differential value-added for prototype verification, test and transfer to manufacturing.
- TAE provides products which integrate computer-aided software engineering (CASE) and mechanical packaging with behavioral system design.

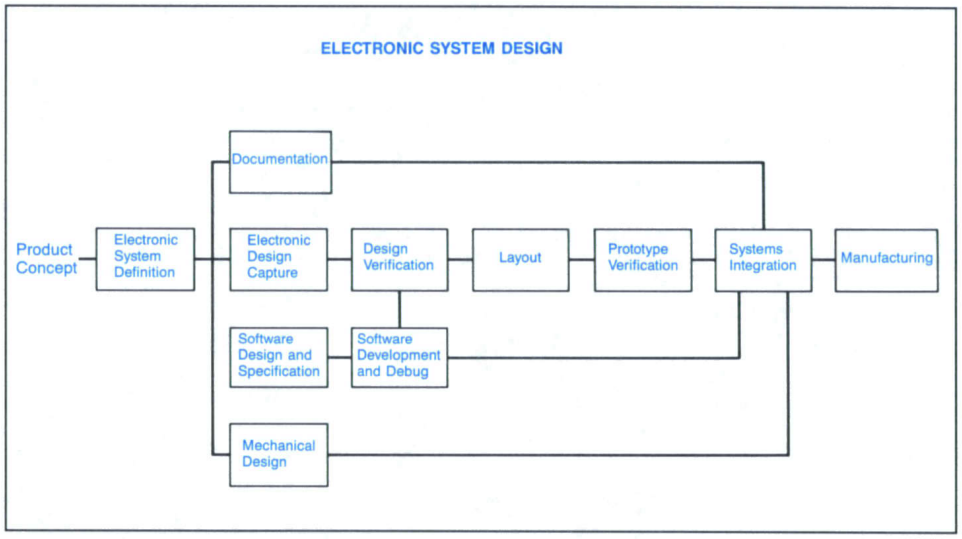
With TAE, design engineers have at their command not only the traditional core CAE functions, but also easy linkage and access to other design and test tools such as CASE, logic analyzers, and semiconductor testers.



TEKTRONIX AIDED ENGINEERING FAMILY FOUNDATION

With complex and quickly changing product design requirements, electronic design engineers need CAE tools that are faster, easier to use, more powerful and more flexible than early CAE workstations. Tektronix is leading this trend by providing a comprehensive set of CAE solutions that offer these important advantages:

- A complete, integrated system that addresses the entire product development cycle—from concept to production.
- Integration of CAE front-end design tools with test and measurement, through a common user interface and database management system.
- Support for team engineering (the ability to leverage the productivity of several engineers, not just one) through networking and distributed database management to provide each engineer immediate access to pertinent design data.
- An open architecture system based on industry standard hardware and software that protects the user's previous CAE investment by providing Tektronix CAE solutions which adapt to existing engineering computing environments.

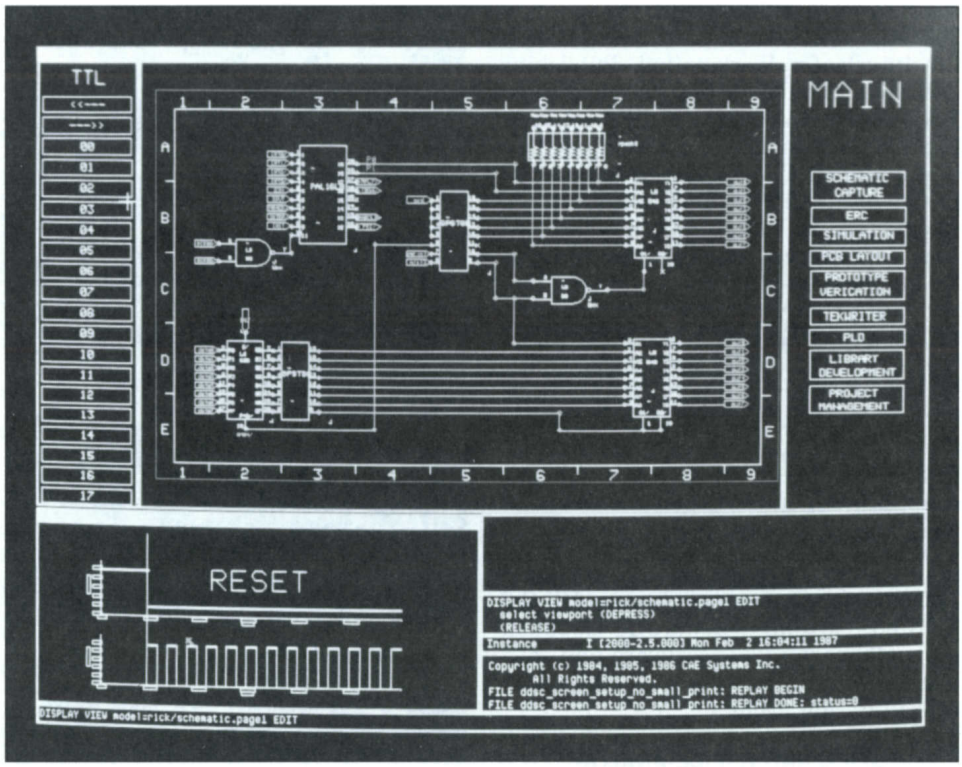


Tektronix Aided Engineering provides an integrated design, evaluation and test solution for the electronic system development process which significantly improves engineering productivity and reduces time to market.

Designer's WorkSystem™

- DDSC™ System for Schematic Capture and Logic Analysis
- Industry Standard HILO-3® LSS for Logic and Fault Verification
- HSPICE™ for Analog Circuit Design Verification of Printed Circuit Boards
- Standard Components Libraries
- TekWriter™ (Interleaf™) Engineering Documentation
- Industry Standard Apollo™, DEC™, and Tektronix Computer Hardware Platforms

The Designer's WorkSystem is a complete environment for conceptual design and analysis. This WorkSystem helps you find simple answers to difficult problems by integrating design capture and verification tools. You can design to specification and test ideas while they're still only ideas.



The Designer's WorkSystem integrates design capture and verification tools with the Tektronix data base for schematic entry and simulation of circuits or boards for analog, digital or microwave circuits.

DESIGNER'S DATABASE SCHEMATIC CAPTURE (DDSC)

The Designer's Database and Schematic Capture (DDSC) system offers a completely integrated, hierarchically structured software system for the design of complex electronic circuits. The software runs under a UNIX™ or VMS™ operating system and works with DEC VAX and Apollo workstations.

Design information in the database can be defined and accessed along two dimensions. Vertically, the user defines hierarchical levels from the most general and abstract (the functional level) to the most detailed (gate or transistor level). Horizontally, design at each level may appear as a behavioral description, in logical symbols, or as a circuit diagram. A one-button "push" command brings any level into view on the screen. The vertical hierarchy permits review and analysis to focus on details such as fanout and loading, when appropriate. Horizontally, the hierarchical structure encourages "what if" and trade-off analysis.

The distinction of the Tektronix Designer's Database Schematic Capture software lies in the nature and design of the database. This proprietary, hierarchically organized database allows the designer to work in his most comfortable style, at any level, from top-down to bottom-up, or in any combination. In the same design, an engineer may define and display some blocks at the functional level, others at the logic level, and others at the circuit level. Since the user defines his own hierarchy, existing design practices need not be altered.

With the Tektronix Worksystems, concurrent design is at your fingertips. Teams of engineers can work simultaneously on different levels. All team members have access to the entire design as it progresses. Because data entered at any design level instantly updates the database, communication among team members is automatic. Analysis and simulation results are available to all team members. The project manager can view the progress of the entire team and check interfaces for compatibility and compliance with specifications. No copying of files or other special integration procedures are required—the design is always integrated. In addition, the networked database is integrated with other tools within the WorkSystems to protect your design data investment. This total concurrent Team Engineering concept is unique to Tektronix.

HILO-3® LOGIC SIMULATION SYSTEM

HILO-3 Logic Simulation System (LSS) is an integrated set of CAE tools from Tektronix for design verification, fault simulation and test generation in IC, PCB, and system design.

The HILO-3 LSS includes a hierarchical Hardware Description Language (HDL) for specifying logic designs, a graphical waveform and textual I/O stimulus interface, a Waveform Description Language for describing circuit stimuli, a Graphic Display Formatter for displaying simulation results, a fault-free logic simulator, a fault simulator, a test generator, a component library that contains models for over 2,500 devices. A 5-state, 15-value logic strength algorithm for accurate modeling of a wide range of device technologies, such as TTL, ECL, Schottky, CMOS, NMOS, PMOS, STL, and 12L is also included. HILO-3 accelerates logic verification through accurate simulation, and provides advanced fault simulation facilities for test pattern analysis. In fault simulation, a new Parallel Value List (PVL) algorithm combines the advantages of concurrent and parallel algorithms, providing fast execution and low memory overhead.

LOGIC LIBRARIES

To reduce design time, Tektronix offers access to a library of over 3,000 standard parts, including those for TTL, FAST, CMOS, ECL and MICRO-P. Systems and IC designers have a wide variety of state-of-the-art implementations for their electrical designs. The libraries provide primative elements from simple gates to complex functions such as I/O buffers, multiplexers, and memories.

TEKWRITER

TekWriter Publications Software is based on Interleaf's Workstation Publishing Software for engineering documentation. TekWriter allows engineers to accelerate, improve and simplify the development of documentation associated with the design of integrated circuits and printed circuit boards. Design graphics and text can be mixed within documents. TekWriter enables the user to edit and format documents, as well as illustrate production quality technical publication. Users can select from various type faces and sizes. Once the design capture stage is completed, the design's performance must be simulated and evaluated. Tektronix provides four tools for this function, depending upon the needs of the particular design.

MICROLINK

This interface between Tektronix HILO-3 LSS and Tektronix' software development tools allows parallel hardware and software development to help to shorten the overall design cycle.

SPICE AND HSPICE ANALOG SIMULATION SYSTEM

To provide analog design verification using DC, AC and transient analysis, Tektronix' DDSC interfaces to the industry standard SPICE circuit simulation program, which provides waveform display output. HSPICE provides analog simulation support with improved convergence and extensive analog device modeling capabilities.

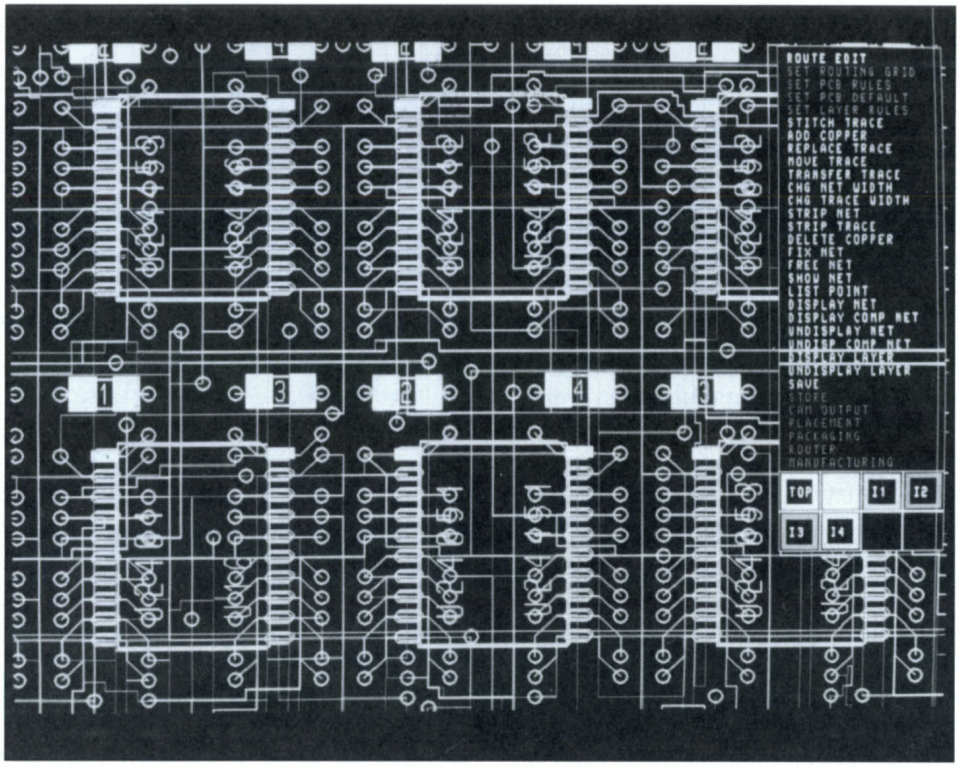
ZYCAD SIMULATION ACCELERATOR

To speed the analysis of complex designs, Tektronix' DDSC interfaces to the Zycad hardware logic simulator, which executes simulations at more than one million events per second.

WAVEFORM DATA LINK (WDL)

The 91-WDL (DASLink), a powerful software utility, ties sophisticated "Tektronix Aided Engineering" tools to the DAS 9100 Digital Analysis System. This close coupling between the CAE workstation environment and prototype verification environment facilitates quick and accurate validation of prototype hardware. The 91-WDL currently operates with CAE Systems' DDSC software on the DEC MicroVAX II and VAXStation workstations, as well as the Apollo line of workstations.

The 92-WDL links logic simulation to the Tektronix 9200 Logic Analysis System and utilizes logic simulation test vectors for prototype verification.



The PCB WorkSystem fully supports surface mount technology by providing color-coded graphic representation of components on top and bottom surfaces of the board.

The ATE-WDL links "Tektronix Aided Engineering" tools with production test, specifically with Tektronix' LT-1000 production tester.

PCB WorkSystem

- **DDSC System for Schematic Capture and Logic Analysis**
- **Industry Standard HILO-3 LSS for Logic and Fault Verification**
- **HSPICE for Analog Circuit Design Verification of Printed Circuit Boards**
- **MERLYN-P™ Automated Physical Layout System for Simple and Fast Layout**
- **Standard Components Libraries are Compatible Between Schematic Capture, Simulation and Layout**
- **Efficient Handling of Engineering Change Orders**
- **Full Forward and Backward Annotation Between Schematic Capture and Layout**
- **System Outputs Support Your Design Process with CAM Outputs, Reports, and Checkplots**
- **TekWriter (Interleaf) Engineering Documentation**
- **Industry Standard Apollo, DEC and Tektronix Computer Hardware Platforms**

The PCB WorkSystem from Tektronix brings your design team every tool needed for complete PCB development.

Design capture, logic simulation, printed circuit board layout, and output for computer aided manufacturing (CAM) are effectively linked, providing an integrated systems environment for your design engineering group. The system accommodates layout and manufacturing constraints on the most complex board designs, including fine-line technology, mixed surface mounted and through-hole devices, and double-sided boards.

The tools offered by the PCB WorkSystem provide design, simulation, and layout flexibility, including separate clearances between vias, traces and pins for each layer of the board. User-definable design rules are enforced through the design process to ensure correct manufacturability.

The WorkSystem fully supports surface mount technology (SMT). By providing a color-coded, graphic representation of components, SMT allows designers to place devices on both top and bottom surfaces of the board. To enhance visual perception, bottom layer components are graphically offset. Single part definition can be mirrored and rotated, as required, for top/bottom orientation. Blind and buried vias are supported, allowing

closer compaction of parts on the board. SMT permits the designer to reduce the board size by as much as 40 to 70 percent, while increasing its overall functionality.

Advanced, customized schematic capture capabilities are provided by the Designer's Database Schematic Capture System (DDSC). The system features a mouse-driven, menu-oriented environment and is the central point of integration of all the tools within the PCB WorkSystem.

To provide an integrated approach for logic simulation, fault simulation, and test pattern generation of digital logic design, the PCB WorkSystem utilizes the Tektronix HILO-3 LSS. To provide analog design verification, the PCB WorkSystem utilizes HSPICE Simulation System. HSPICE is based on Meta-Software's HSPICE circuit simulator.

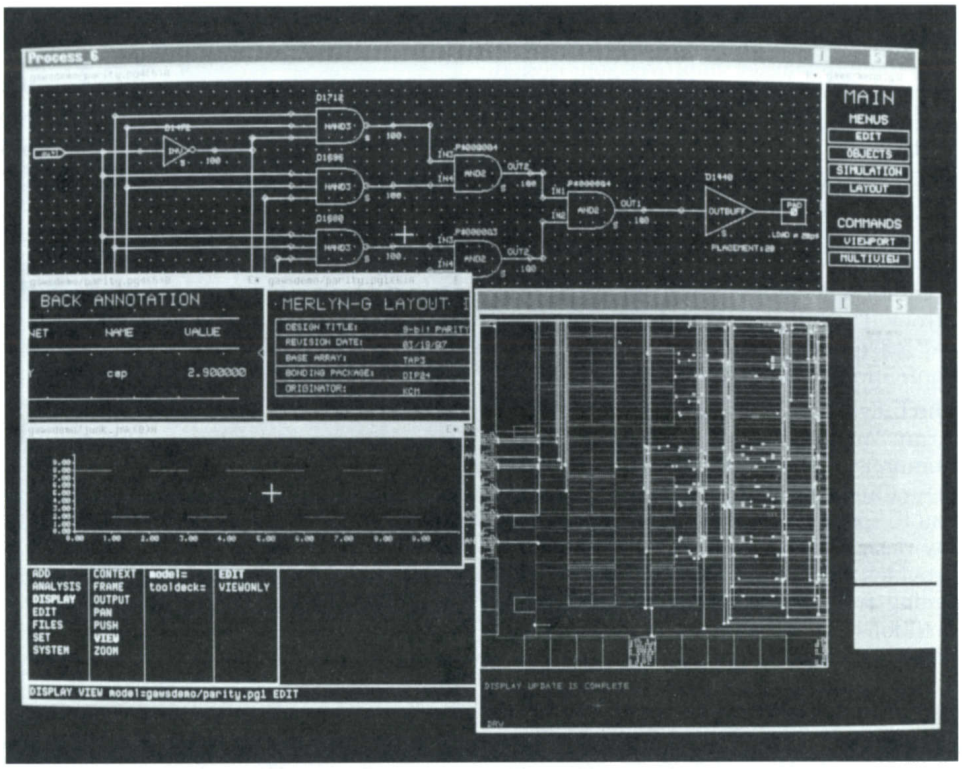
For automatic physical layout of printed circuit boards, the PCB WorkSystem features the MERLYN-P physical design system. The integrated design of the product features a comprehensive database that contains all data needed for board layout. MERLYN-P is menu-driven, has on-line HELP for all commands, and features user-defined layout design rules that you can customize to meet special requirements and standards. Complete forward and backward annotation of design data between MERLYN-P and DDSC is provided by LogicLink-P.

Engineering Change Orders may be completed without redesigning the entire board. When the changes are completed, the schematic is back annotated to reflect the circuit revision status.

The PCB WorkSystem library includes several thousand parts, including TTL7400 and discrete parts, that are complete and compatible with the WorkSystem's schematic capture, simulation and layout environment. Other compatible libraries, including CMOS and microprocessor parts, are optionally available.

The Tektronix TekWriter engineering documentation system is an easy-to-use publishing tool for creating high quality, illustrated documents. TekWriter enables you to write, edit, format text, and create graphics from the DDSC environment to produce camera-ready copy suitable for technical documentation.

To effectively link your printed circuit board layout processes to an automated manufacturing environment, the PCB WorkSystem generates the necessary standard artwork, checkplots, documentation and data. The PCB WorkSystem is available on industry standard platforms for DEC and Apollo.



The Gate Array WorkSystem offers you the complete design solution featuring a single, integrated user interface for full control of design capture, simulation, and automatic layout directly from the schematic.

Gate Array WorkSystem

- **DDSC Integrated System Environment Provides Optimal Gate Array Design**
- **HILO-3 LSS Provides Industry Standard Logic Simulation Solutions**
- **MERLYN-G™ Performance-Driven Physical Layout is Controlled Directly from the Schematic with Full-Forward Annotation of Layout Parameters**
- **Automatic Back Annotation of Layout Results to the Schematic Allows Analysis of Layout on Circuit Performance**
- **TurnChip® ASIC Layout Modules Deliver Foundry-Quality Layout Results**
- **Certified Library Support Assures Accurate and Rapid Implementation of Your Designs**
- **Multiple Configuration Possibilities Provide Maximum Flexibility in Your Computer Operating Environment**
- **Industry Standard DEC VAX, Apollo DOMAIN and Tektronix Color Platforms are Supported**

The Gate Array WorkSystem from Tektronix is an integrated set of design tools that provides a complete solution for gate array design.

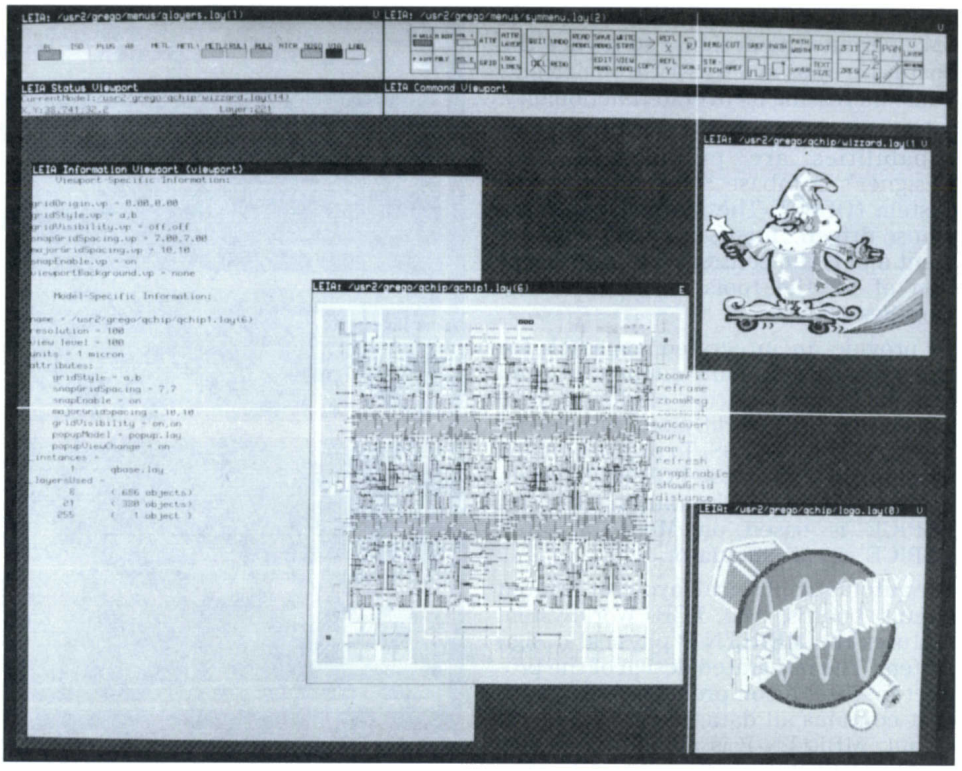
Put the power of Tektronix Aided Engineering at your control with the performance-driven design environment created by the Gate Array WorkSystem. Every tool needed for complete gate array design implementation is provided, including schematic capture, logic and fault simulation, timing verification, and automated "push button" gate array physical layout. All the tools are integrated to simplify the interfaces between logic capture, simulation and physical layout, bringing the entire design process under your control to assure your designs meet your performance requirements.

The Gate Array WorkSystem offers you a complete toolset that effectively reduces your time to market, improves your design performance, provides proprietary design control, and reduces your overall design costs.

The Gate Array WorkSystem features a single, integrated design interface that has been optimized for gate array design. This integrated system provides a single control point for schematic capture, simulation and layout. The interface is menu-driven, easy to learn and use, and allows user-configurable menus for added flexibility.

The fully-automated capability of the Gate Array WorkSystem allows local, multiple iterations of schematic capture, simulation, layout and resimulation, thereby allowing you to spend more time optimizing gate array design performance. The system also provides direct control of physical layout timing from the schematic. Forward annotation of layout parameters and back annotation of layout results occur directly on the schematic, providing immediate design performance verification.

In addition, the Gate Array WorkSystem features foundry-endorsed TurnChip ASIC Layout Modules for automatic foundry-certified layout. With TurnChip automatic layout, you spend your time achieving design objectives, so you send foundry-certified layout designs, rather than simple netlists, directly to the foundry. The need for iterations with the foundry is minimized, dramatically reducing your time to market.



The Full Custom WorkSystem combines custom design capture, simulation and layout tools into one powerful solution.

Full Custom WorkSystem

- **Direct Read and Write of Calma GDSII Files, Which are Passed Directly into and Produced Directly from, LEIA's Internal Data Structure without any Intermediate File**
- **LEIA™ Provides a Flexible Editing Environment that is Unparalleled in the Industry. Virtually Every Environmental Aspect can be Controlled by the User without the Need to Learn a Complicated Programming Language or Leave the Editing Session**
- **Industry Standard DEC and Tektronix Color Platforms are Supported**

Developed by Tektronix as part of Tektronix Aided Engineering, the Full Custom WorkSystem combines custom design capture, simulation and layout tools into one powerful solution. This WorkSystem provides tools for complete custom IC design implementation including Designer's Database Schematic Capture (DDSC), non-linear and linear (microwave) simulation, LEIA custom IC and hybrid layout editor, and DRACULA™ IC mask verification and fracturing tool.

LEIA is a powerful interactive graphical layout editor for custom integrated circuit design with full utilization of hierarchy.

LEIA's flexible user interface provides the designer with multiple windows, pop-up menus and the ability to customize a real time user-configurable menu environment. This promotes ease of use in layout for even the most complex VLSI circuits.

DRACULA is a full set of integrated software to help the designer verify the IC mask layout. These tools include Design Rule Checker, Electrical Rule Checker, Layout vs. Schematic Consistency Checking, Layout Parameter Extraction, Layout vs. Layout, Plot and Mask Fracturing. Once a design is captured in DDSC, the *"generate dracula"* command will automatically generate an LVS-compatible netlist. ERC, DRC, LPE, LVS, and LVL will generate textural listings of any discrepancies, or errors, as well as graphical overlays for the LEIA Layout Editor.

Signal Processing WorkSystem

- **Proprietary Simulation Program Builder**
- **Rich DSP Function Block Library**
- **Flexible Signal Editor**
- **Integrated Instrument Interface Library**
- **Industry Standard DEC, Apollo and Tektronix Platforms Supported**

The Signal Processing WorkSystem™ (SPW) allows the DSP designer to use the most advanced CAE tools to design DSPs. The DSP designer does not have to become a programmer or even a hardware expert. He or she can concentrate on the system level performance.

The SPW provides the functionality of signal definition, signal capture, DSP block capture, netlist generation, interface to DSP simulation and signal analysis. The SPW consists of a workstation platform, block diagram editor and database (DDSC), function block library, Simulation Program Builder (SPB), Signal Display Editor (SDE), and Instrument Interface Library (IIL)/Data Acquisition System.

Designer's Database Schematic Capture (DDSC)

DDSC, the core of Tektronix CAE products, creates a menu-driven environment that captures and analyzes designs using various types of signal processing blocks. These blocks are then edited and manipulated into a graphical representation of a signal processing system. This representation is then condensed into a netlist file.

Function Block Library

The function block library consists of signal processing blocks used with DDSC to construct and simulate a signal processing system. An extensive list of library blocks is supplied with the SPW. These blocks fall into 10 major classes:

- DSP Kernels
- Linear Processing
- Non-Linear Processing
- Mathematical
- Statistical
- Adaptive Filtering
- Signal
- DSP Chip Modeling
- Vector Recombination
- Flow of Control

Virtually any signal processing system can be represented as a collection of these blocks connected by lines. Each block symbolizes a mathematical operation. Interconnecting lines symbolize the flow of data from mathematical operation to mathematical operation.

In addition to these basic functional blocks, the designer can add multilevel and coded blocks. Multilevel blocks are constructed by the user and represent a signal processing function built out of combinations of basic, coded and other multilevel blocks. Coded blocks are inserted into the system and implement a "custom" function. Each is associated with a source code (user supplied) that represents the functionality. Once created, coded and multilevel blocks can be used just like the supplied basic building blocks.

Of particular interest are the signal source and sink blocks for both scalar and vector I/O. Source blocks get their information from a file produced using the Signal Display Editor, from the Data Acquisition System or by a previous simulation run. Storage or sink blocks reverse the process and store the output in a user specified file and format. These blocks are capable of reading and writing SPW database format files or ASCII format files.

Simulation Program Builder (SPB)

The SPB takes the netlist file produced by DDSC and converts it into a program that simulates the behavior of the signal processing system. Netlist generation and simulation execution are invoked directly from the command menu of DDSC and provide seamless system operation. The input and output files used during a simulation are user specified as signal blocks.

Signal Display Editor (SDE)

The SDE generates, manipulates and analyzes signals and operates in a separate process window from the DDSC/SPB window. The command structure and operation is identical to DDSC, again insuring a seamless system for the user.

Signal editing modifies a signal by changing, adding, deleting or searching for signal point values. The SDE also contains many commands for performing linear and non-linear filtering operations on an editable signal. Linear filtering commands include high, low, bandpass and notch filtering, plus the ability to filter the signal using a functional block, which has been created by the user in DDSC/SPB and added to the library. Signal decimation and interpolation are also included under linear filtering. Nonlinear filtering commands include quantization, zero crossing, clipping, and exponential expansion and compression.

A full set of signal generation commands for sine, square wave, triangle, sawtooth and noise signals are available in the SDE.

Equally important to the task of generating input signals for the SPW is the SDE capability to analyze the results of a DSP simulation run. The commands available in the command builder under the ANALYSIS command run the gamut from differencing two signals through auto- and cross correlation to FFT spectral analysis.

Instrument Interface Library (IIL)/Data Acquisition System

A key element in making full use of the SPW is an Instrument Interface Library that ties directly into a Data Acquisition System. The SPW is capable of receiving and transmitting data and instructions over a GPIB or RS-232C. Special input and output blocks, callable by DDSC and integrated in the DSP design, give the user complete access to GPIB calls. The user can use these blocks to set up external instruments such as function generators and digital oscilloscopes, capture a signal in real time, import that signal into the SPW, process that signal (not in real time) and then analyze the results and send that signal out through the GPIB for use in the real world.

As an example, the user simply adds an IIL block labeled TEK11401 (a digitizing oscilloscope) to his captured design. Pushing down into that block, he is prompted for the various scope settings, such as sample rate, frequency range, etc. Then, based on these parameter entries, the IIL part automatically formats the GPIB calls that program the 11401, waits for the proper trigger, imports the data, starts the simulation and captures the results. If an output over the GPIB is indicated by another IIL or generic GPIB block, this will also be handled automatically.

With the SPW, designers no longer need to worry about programming and debugging a custom simulation program for each DSP system they design. The SPW automatically converts their DSP design into a bug-free simulation program. Designs that typically took weeks to simulate and verify can now be simulated in as little as a few hours.

The Signal Processing WorkSystem provides the most complete I/O and design capture system for digital signal processing available today. It allows the designer to get as close or far away from the actual design as he wants. It allows quick and efficient "what-if" analyses and even allows the user to test his design with real-world data. It is the most productive tool a DSP designer can use.

MERLYN-P Automated Printed Circuit Board Layout

- **Autopackaging Capability Provides Extra Flexibility**
- **Continuous Verification of Layout Data Assures Accuracy of Board Designs**
- **Extensive Parts Library**
- **Design Rules Control Design Process**
- **Auto/Interactive Tools Simplify Component Placement**
- **Placement Optimization Capabilities for Improved Board Placement Results**
- **Wiring Optimization for Improved Manufacturability of Designs**
- **System Output Supports Your Design Process—Reports, Checkplots, Neutral File Access and CAM Outputs**

MERLYN-P is a physical design system for automatic/interactive component placement and routing of printed circuit boards. The integrated design of the product features a comprehensive database that contains all data needed for board layout.

The system is menu driven, has an on-line help feature for all commands, and features user-defined layout design rules that you can customize to meet your special requirements.

MERLYN-P is fully integrated into the Tektronix PCB WorkSystem and provides an easy-to-use system for design, simulation and layout of printed circuit boards.

MERLYN-G Automated Gate Array Layout

- **Graphical Database Manager Speeds Accurate Database Creation**
- **Automatic Placement Tools Optimize Circuit Layout**
- **Automatic Routing Tools Provide Tuning Controls for Difficult Layout Problems**
- **Interactive Graphical Editors are the Designer's Layout Workbench**
- **System Output Supports Your Design Process**
- **Industry Standard Platforms are Supported**

MERLYN-G features 100% automatic placement and routing for personalizing a variety of array families. Sophisticated, state-of-the-art algorithms allow the system to solve the difficult layout problems circuit designers are facing today.

MERLYN-G uses time-proven design automation techniques to perform layout functions such as device/macro placement, routing and wire path optimization, with no system limits to chip size or macro geometry. The system's open architecture allows direct interface to your existing design tools through the published design file format.

MERLYN-G is fully integrated into the Tektronix Gate Array WorkSystem, providing you with a complete end-to-end system for the design, simulation and layout of gate arrays.

MERLYN-S Automated Standard Cell and Block Layout

- **MERLYN-S Supports Designs with Standard Cells, Macro Blocks, or a Mix of Both**
- **Graphical Database Manager Speeds Accurate Database Creation**
- **Complete Access to the MERLYN-S Database Provides Easy Integration with Other Programs**
- **Automatic Placement Tools, Using Tektronix' Quadratic Placer, Optimize Circuit Layout**
- **Automatic Routing Tools Support "Well Space," Compaction, and Tapered Power/Ground Routing**
- **Automatic Block Routing Breaks the Cyclic Channel Routing Trap**
- **Interactive Graphical Editing Tools Give the Designer Complete Control of Placement and Wire Routing**

MERLYN-S features 100% automatic placement and routing for standard cell and block physical layout.

Sophisticated algorithms, proprietary to Tektronix, enable superior handling of the large, complex circuit problems facing designers today. These algorithms support traditional processes, as well as the special requirements of newer technologies such as VHSIC and GaAs.

MERLYN-S offers strong graphical facilities that allow you to interactively place devices, preroute or edit wire paths, or modify the results of automatic placement.

Customer Support Services

To help our customers make best use of automated tools, Tektronix provides an extensive range of after-sale support services. By establishing this kind of long-term relationship, Tektronix enables you to keep up with advances in automation and realize all the advantages of Tektronix Aided Engineering.

SOFTWARE SUBSCRIPTION SERVICE (SSS)

The Software Subscription Service Plan provides continued software and information updates reflecting the latest design and applications changes from Tektronix/CAE Systems. In addition to keeping you constantly informed with the latest product information, the SSS also offers information about correct systems use, and access to free information exchange with other system users.

TECHNICAL ASSISTANCE SERVICE (TAS)

The Technical Assistance Service provides expert-level technical assistance for new system installation or enhanced existing operation. TAS offers consulting support to speed new application development and guided instruction for time-critical applications that puts systems on-line immediately.

DESIGN PRODUCTIVITY CENTER (DPC)

The Tektronix Design Productivity Centers are a unique environment where technical consultation can be directly applied to actual customer designs.

CUSTOMER TRAINING

Tektronix/CAE Systems training courses teach and enhance the skills needed to productively use Tektronix WorkSystems. Our curriculum constantly expands to meet growing technical needs. The training staff is made up of experienced instructors with solid technical knowledge. Instructors update course materials as they work with customers, engineers, writers and in-house users, and search for stimulating ways to pass on information to students.

COMPUTER-AIDED SOFTWARE ENGINEERING (CASE)

Tektronix is committed to providing solutions for the emerging CASE marketplace—a logical fit for our expertise. TekCASE's goal is to provide a functional and integrated tool set for software design engineers—software life-cycle management from concept to completion to maintenance.

These design solutions are integrated in CASE's life-cycle software tools and automate the transformation from one software development phase to another.

Current key products include: TekCASE Analyst, TekCASE Designer, TekCASE Auditor and Language Development Systems (LANDS I, II), V-Systems 16-bit microprocessor development systems for 68000 family and 1750A, and a Multi-V System—32-bit microprocessor development system for the Motorola 68020.

CASE products provide a carefully configured and integrated system of automated tools applied to the software life-cycle.

The integrated CASE tool set, when linked to the user's design information database, enables the software designer to rapidly and proficiently develop specifications, designs, plans, code, manuals, and reports.

Tektronix is continuing to evolve its CASE solutions by more tightly integrating its support for the different phases, extending the capability of its automated tools, adding new alternative tools, and expanding its support for software development on engineering workstations.

To support the analysis and design phases of the software life-cycle, the Tektronix CASE strategy makes TekCASE Tools available in the most common computer environments.

To help automate documentation efforts, the TekCASE Auditor provides the framework for DOD-STD-2167A documents, including System Segment Specifications (SSS), Software Requirements Specifications (SRS), and Software Top-Level Design Documents (STLDD). The Auditor allows you to identify requirements within design documents and to track the relationship between these requirements.

In addition, the Auditor allows you to track relationships between documents and the diagrams they include. The tools also include an interface to technical publications system for both easy document preparation and high quality output.

In the code, test, and integration phases, Tek's CASE offering for code development and debug tools is the high-level Language Development System (LANDS I, II). This integrated set of language development tools, originally released by Tektronix in 1982, includes a Language Directed Editor (LDE), a C or Pascal compiler, integration control systems, a high-level debugger, and an assembler/linker for popular 8-, 16-, and 32-bit microprocessors.

The LANDS system works with Tek's emulation product lines to provide a complete integration facility. This popular solution for microprocessor support is the result of providing solutions to the embedded microprocessor market for over ten years. Our close working relationship with Tektronix Laboratories links us with a major software research and development facility, and we have the technological and financial resources needed to be a premier CASE vendor. We are committed to helping software designers who need the total support only a firm like Tektronix can provide.

The Tektronix CASE product set is powerful proof of Tektronix' software leadership. Meeting your needs through integrated, automated solutions to manage the software life-cycle—is Tek's mission.

CONTENTS

Introduction 91
CASE
Software Life Cycle Phases 92
TekCASE Analyst 93
TekCASE Designer 94
MDP
LANDS I—16-Bit C and Pascal Systems 95
LANDS II—32-Bit C Systems 96
V Systems—8- and 16-Bit Development System 97
Multi-V System—32-Bit Development System 98
68HC11 Development System ... 99
Defense/Aerospace Applications . 101
Services 102

Software Life Cycle Phases

1. Analysis
In the analysis phase, the software engineer specifies what a software system must do to meet its user's requirements. Data flow diagrams and process descriptions define data and the processes that transform it. A data dictionary describes how data is structured. These components comprise a specification for the software system upon which a design is based.

2. Design
In the design phase, the specifications from the analysis phase are automatically transformed into a software module design. Logic modules and algorithms are created so solution prototyping can begin.

3. Prototype
In the prototype phase, prototyping tools allow the software engineer to test the hypotheses posed in the analysis and design phases. The detailed design of the solution to be implemented can be tested and refined during this phase.

4. Code
In the code phase, the software engineer needs tools to produce executable code in a particular language on a computer or workstation. If the software is being developed for an embedded microprocessor, the coding tools on the development computer require cross-development tools to produce code that will execute on the target microprocessor.

5. Test
In the test phase, an interactive source level (or symbolic) debugger assists the software engineer in testing the software in accordance with the requirements and specifications defined in the analysis and design phases. The debugger should allow the user the ability to test a program on both the development computer and the target system.

6. Integration
In the integration phase, the final testing and verification of the software must be performed where the software is actually used. Software/hardware integration is performed using symbolic debuggers if the software is to execute on a traditional computer or workstation, or using a symbolic debugger linked to a software/hardware integration unit and emulator for embedded microprocessor targets. In addition, test cases resulting from the analysis and design phases are used to ensure the software meets its requirements.

7. Maintenance
In the maintenance phase (after the software is developed), tools used in the previous six phases can be put to work making changes, or detecting and correcting defects in the software. Another traditional task may include installing customer requested enhancements, identifying and resolving problems, or assisting customers in the proper usage of the software. The maintenance phase is required documentation that defines what software product was developed, how the software product was developed, what can be changed, and how to make the change.

TekCASE Analyst/RT

- **Improve Product Quality and Reduce Development Time and Cost**
- **Specify Real-Time Systems Graphically to DeMarco SA Method with Hatley or Ward/Mellor Extensions**
- **Automatically Check Completeness and Consistency, Analyze Data, and Control Information**
- **Use Any VAX Host, Including VAXstation 2000, in Any Configuration**

Improve Quality and Control Costs

A specification that accurately defines system requirements can better ensure project success, in turn, improving product quality and controlling costs. With TekCASE Analyst/RT Tools you can accurately define system requirements from the very beginning.

Using vivid graphics and precise descriptions to define a system model, TekCASE Analyst/RT allows you to see what your system will do, before you decide how the system will do it. Project members, management, and users can easily understand the proposed system, and verify that it will meet specification requirements. Then, both costs and product quality can be better controlled.

Specify Systems Graphically

With the TekCASE Analyst/RT graphics editor, you create Control Flow Diagrams, Data Flow Diagrams and other documents; also create, label, move, change, or delete symbols for processes, data and control states of your system. When using TekCASE Analyst/RT Tools, the documents and symbols are specific to support real-time system specification: control flow diagrams, specs, transforms, processes, stores, flows, and time-continuous flows. Using the graphics editor, you move through a specification, creating "child" diagrams, control specifications, and "mini-specs" (defining the actions within a process). With a text editor you create and modify the data dictionary and other textual documents. To see the results of your graphics and other editing, a display tool shows documents on a terminal screen or in hardcopy form.

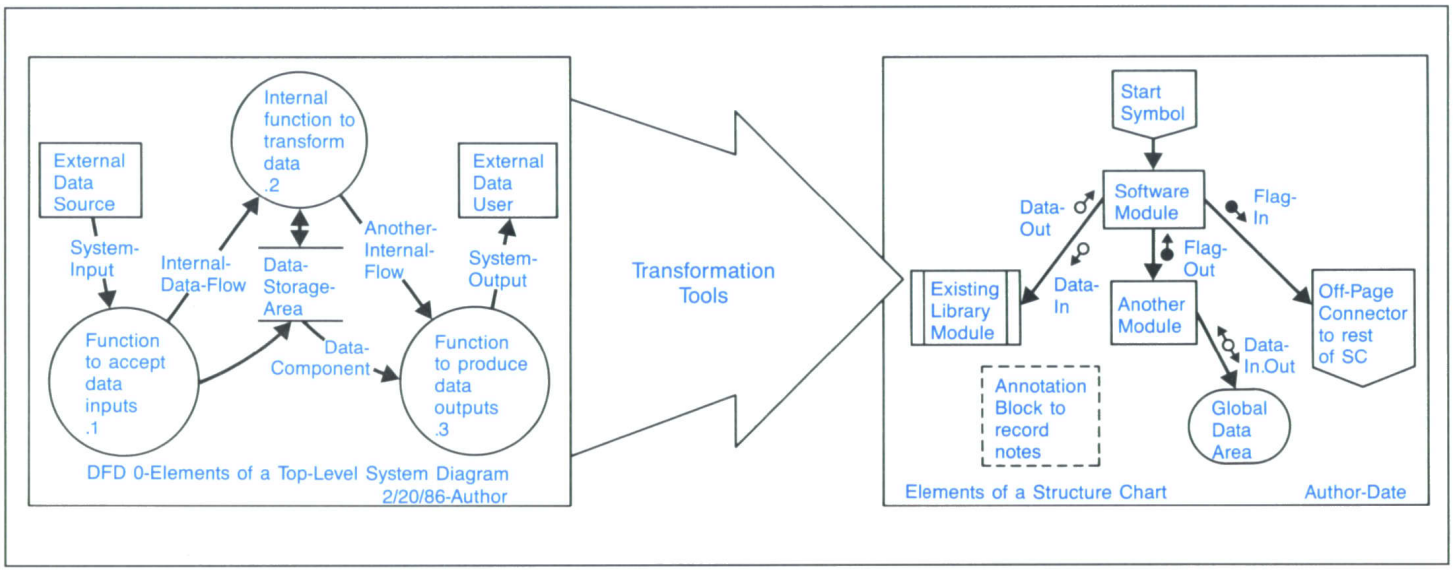
TekCASE Analyst/RT automates the tasks required in specifying a real-time system: drawing diagrams, organizing documents, checking details, preserving consistency, and making copies. It does this by providing a set of tools for editing, evaluating, updating, and display. It also allows you to perform a number of complex tasks, by combining TekCASE Analyst/RT Tools' commands with each other or with operating system commands.

TekCASE Analyst/RT supports both the Hatley and Ward/Mellor real-time extensions to the DeMarco SA method. For reference, see *Strategies for Real-Time and General Systems Development*, by Derek Hatley and Imtiaz Pirbhai; *Structured Development for Real-Time Systems*, by Paul T. Ward and Stephen J. Mellor; and *Structured Analysis and System Specification*, by Tom DeMarco.

Check Completeness and Consistency, Analyze Data, and Control Information

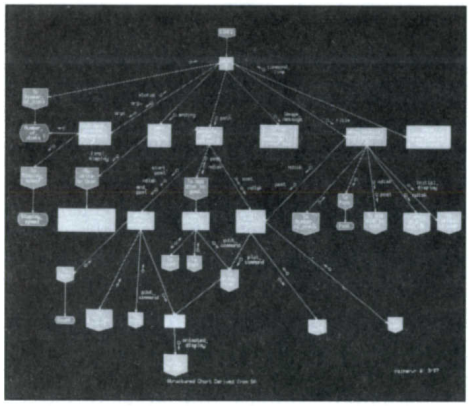
Both TekCASE Analyst/RT and TekCASE Designer provide tools to automatically check completeness and consistency, to analyze data, and control information. An evaluation tool checks data and control information for consistency, completeness, and adherence to the SA method and the real-time extension. An updating tool creates new documents and corrects errors (relating to the SA method). Auxiliary tools perform certain maintenance tasks, and retrieve specific information from your SA documents. The maintenance tasks include adding new entries to the data dictionary, listing and showing definition of entries from the data dictionary or other documents, listing process information from diagrams or mini-specifications, and sorting and eliminating unnecessary duplication in the data dictionary.

See the next page for ordering information.



TekCASE Analyst/RT Tools create a set of interrelated data flow diagrams and descriptions that show the active functions of the system and its interfaces.

TekCASE Designer Tools create a structure chart that graphically depicts the software architecture, with symbols showing modules and their controlling and communicating relationships.



TekCASE Designer Tools

- **Transformation from Analysis to Design**
- **Design Software Systems Architecture**
- **Foundation for Detailed Design and Code**
- **Structured Maintenance of Existing Code**

TRANSFORMATION TOOLS: BRIDGING ANALYSIS AND DESIGN

TekCASE Designer Tools transformation utilities automatically convert system specification diagrams into software design charts that include the same function and data specified during analysis.

Interactive transformation tools allow rapid "what-if" designs that encourage innovation and creative problem solving. Designers can then continue the creation of optimal designs using TekCASE Designer Tools.

TekCASE Analyst/RT and TekCASE Designer products are integrated to guarantee that specification information is automatically preserved in the design process.

PLANNING SUCCESSFUL SOFTWARE

TekCASE Designer Tools help you build your software the right way—the first time—by supporting disciplined planning of software implementation.

The output of TekCASE Designer Tools is a set of diagrams for the entire software architecture which rigorously defines how the software is to be implemented.

Finding the Best Design

TekCASE Designer Tools develop a structure chart (SC) that graphically illustrates the partitioning of a system into modules, showing hierarchy, organization, and interfaces. The structure chart conveys complex architectural information quickly and clearly.

Evaluation tools and an interactive editor for those structure charts enable designers to produce the best design for implementing the software.

Blueprint for Implementation

Because the structure chart is strictly partitioned with clearly specified interfaces, it is ideal for team development on large projects. After design is complete, the structure chart serves as a blueprint for detailed design and coding.

Detailed Design and Coding Foundation

TekCASE Designer Tools automate the Structured Design method of software design, which is described in *The Practical Guide to Structured Systems Design* by Meilir Page-Jones.

Transforming Specs to Designs

Transformation tools generate design alternatives for real-time projects, interactively converting the specifications that are created with TekCASE Designer Tools, into structure charts. The designer designates one process as the controlling module where software execution will start.

Editing Structure Charts

A special purpose, interactive graphics editor lets designers create and modify structure charts on-line. Designers can create, label, move, and delete each type of symbol in the chart. Groups of symbols can be moved or deleted, and structure charts can be joined or split off into related files associated by page connectors. A reformatting utility rearranges a structure chart into a top-down hierarchy.

Evaluation and List Tools

The evaluation and list tools let designers check design quality and extract design information.

For project continuity the evaluation tool lets engineers identify the simplest alternative and validate the finished design and code. The evaluation tool checks for defects and inconsistencies among SCs, warns of deviations from the SD method, reports statistics about SC modules, and measures system complexity within the SC hierarchy.

The list tool provides the "module calling tree" for the SC files, and information about data item references, modules called, data item locations and parameter usage. This output is produced in a form specified by a user-defined configuration file. Reporting the design information in the user's format supports documentation, detailed design, and code.

Structured Maintenance

Designers can also use TekCASE Designer Tools to enhance existing software. A set of utilities automatically converts source code (the C language is initially supported) into structure charts. The resulting view of existing architecture facilitates maintenance projects.

Host Support

TekCASE Analyst/RT is the first CASE product to support the entire line of VAX computers: VAX, MicroVAX, and the VAXstation, including the II, II/RC, II/GPX, and 2000; it runs under the VMS operating system. TekCASE Analyst/RT supports Tek and Digital terminals, PostScript, and LN03+ hard-copiers. For easily learning TekCASE Analyst/RT, the product works with ColorKey+. Other TekCASE Designer Tools products run under UNIX and ULTRIX, and on the IBM PC.

ORDERING INFORMATION

The following shows the product prices for TekCASE Analyst/Real-Time and TekCASE Designer Tools. These prices represent the standard product package, including media and documentation. For prices on other options (extra documentation kits, update kits, Software Subscription Service), contact your local Tektronix sales engineer.

TekCASE Analyst/RT can be ordered under the following nomenclature:

SATRT1 VAX 8600 and above	$10
SATRT2 VAX780-85XX	$10
SATRT3 MicroVAX and VAX 725, 750	$10
SATRT4 VAXstation	$10

TekCASE Designer can be ordered under the following nomenclature:

SDT1 VAX 8600 and above	$10
SDT2 VAX780-85XX	$10
SDT3 MicroVAX and VAX 725,750	$10
SDT4 VAXstation	$10

IBM PC SUPPORT

TekCASE Analyst (without real-time capabilities) is available on the IBM PC.

SAT5—IBM PC Support	$10

For more information, contact your local Tektronix Sales Representative.

LANDS I

16-Bit Language Development Systems

- **Complete C/Pascal Code Generation Systems**
- **Integrated Set of Software Development Tools**
- **Tightly Linked With 16-Bit Emulation Systems**

After using TekCASE Analyst Tools to develop your system specifications and TekCASE Designer Tools to design your software modules, you're now ready to develop and debug your code. Tektronix' Language Development Systems (LANDS I and LANDS II) offer a comprehensive set of tools for the development, debug, and integration of your software modules.

LANDS I

Using a high-level language to generate code for microprocessor has advantages over assembly-language programming since programs are easier to understand and maintain and programmer productivity is higher. To support this approach, Tektronix offers a language-oriented development system for C or Pascal called LANDS I. The LANDS I package is an integrated set of 16-bit language development tools consisting of a Language-Directed Editor (LDE), a compiler (C or Pascal), an Integration Control System (ICS), a high-level-language symbolic debugger, and a 16-bit macro assembler and linker. These products allow you to work through the software development and debug cycle in the same high-level language from code entry through debugging.

Language-Directed Editors

The Language-Directed Editor included in the LANDS I package is an editor that understands C or Pascal syntax. LDE flags any syntax errors in the source code while you are still in the editor, so that the errors can be corrected immediately. LDE is also an excellent general-purpose screen-oriented editor.

Compilers—C and Pascal

For high-level-language programming, the LANDS I C and Pascal cross-compilers contain many enhancements for microprocessor programming.

These enhancements include interrrupt handling, bit-level data manipulation, assignment of variables to specific hardware addresses, and direct access to I/O ports without having to resort to assembly language code. The LANDS I C compiler supports Kernighan and Ritchie's standard C and the proposed ANSI C standard and includes an implementation of the standard I/O libraries.

Integration Control System (ICS)

One major task associated with microcomputer design is to correctly interface the software with the specifics of the prototype hardware.

LANDS I includes a unique tool for implementing the hardware/software interface called the Integration Control System. The user fills in a brief source file with parameters defining the software modules and hardware configuration. From this source file, ICS automatically handles the details and generates the necessary code and command files to execute code in the target system.

High-Level Debug—C and Pascal

Program debugging is a tedious and time-consuming task. Tek's LANDS I debug system increases your productivity by enabling you to debug code at the source-code level.

Breakpoints can be set on statement numbers, procedure and function names, or on variables to halt program execution. Values can be returned to calling functions. This approach completely eliminates the time-consuming requirements of translating assembly-level debug information into its high-level counterpart.

In addition, your program and variables can be displayed in high-level source form, which speeds the analysis.

8- and 16-Bit Assemblers and Linkers

Tek assembler packages consist of an assembler for the specific microprocessor, a sophisticated linker for locating code, and a library generator for creating source code for object modules and reusing object modules previously created. Tektronix' assemblers and linkers include many features that are normally associated only with high-level coding.

ORDERING INFORMATION

LANGUAGE DEVELOPMENT SOFTWARE

C and Pascal LANDS I

Includes: HLL compiler, assembler, LDE, ICS, HLL debug

CLAN68K C Support for 68000/08/10	$10
CLAN86 C Support for 8086/8088/186/188	$10
PLAN68K Pascal Support for 68000/08/10	$10
PLAN86 Pascal Support for 8086/8088/186/188	$10

OPTIONS

Option 1C—VAX/ULTRIX	+ $9,990
Option 1F—VAX/VMS	+ $9,990
Option 1K, 1L—MicroVAX ULTRIX	+ $8,490
Option 1M, 1N—MicroVAX VMS	+ $8,490
Option 3S—Software Subscription Service	+ $1,000

ASSEMBLERS

ASMZ80 Z80/NSC800 Assembler	$10
ASM8085 8085 Assembler	$10
ASM6809 6809 Assembler	$10
ASM1750 1750 Assembler	$10
ASM68K 68000/08/10 Assembler	$10
ASM8086 8086/8088/186/188 Assembler	$10

OPTIONS

Option 1C—VAX/ULTRIX	+ $2,490
Option 1F—VAX/VMS	+ $2,490
Option 1K, 1L—MicroVAX ULTRIX	+ $1,990
Option 1M, 1N—MicroVAX VMS	+ $1,990
Option 3S—Software Subscription Service	+ $200

EDITORS

CLDEDIT C Language-Directed Editor	$10
PLDEDIT Pascal Language-Directed Editor	$10

OPTIONS

Option 1C—VAX/ULTRIX	+ $1,490
Option 1F—VAX/VMS	+ $1,490
Option 1K, 1L—MicroVAX ULTRIX	+ $1,490
Option 1M, 1N—MicroVAX VMS	+ $1,490
Option 3S—Software Subscription Service	+ $150

COMMUNICATIONS

ICOM40A Integrated Communications System for V Systems	$10

OPTIONS

Option 1C—VAX/ULTRIX	+ $1,990
Option 1F—VAX/VMS	+ $1,990
Option 1K, 1L—MicroVAX ULTRIX	+ $1,490
Option 1M, 1N—MicroVAX VMS	+ $1,490
Option 3S—Software Subscription Service	+ $200

IBM PC SUPPORT

Many of the above products are available on the IBM PC. Contact your Tektronix CASE Division Sales Representative for additional information.

LANDS II

32-Bit C Language Development System

- **32-Bit C Optimizing Compilers**
- **Kernighan and Ritchie/ANSI C Compatibility**
- **32-Bit Assembler and Linker**

32-bit microprocessors have advanced microprocessor technology to the point where mainframe applications can now run on microprocessor-based systems. A corresponding advancement in software tools technology is needed to take advantage of these new microprocessors.

Using all the knowledge gained in the highly successful LANDS I products, the LANDS II product was developed specifically for large application programs running on 32-bit microprocessors. LANDS II products are true 32-bit products including the assembler, compiler, and linker. The first product in the LANDS II product line is a 68020 C Language Development System.

68020 C-LANDS II

Included in LANDS II are:

- C Language-Directed Editor (CLDE)
- 68020 32-bit C Compiler
- Integration Control System (ICS)
- 68020 32-bit Assembler
- 32-bit Linker
- Powerful TekDB HLL Debug System

C Language-Directed Editor

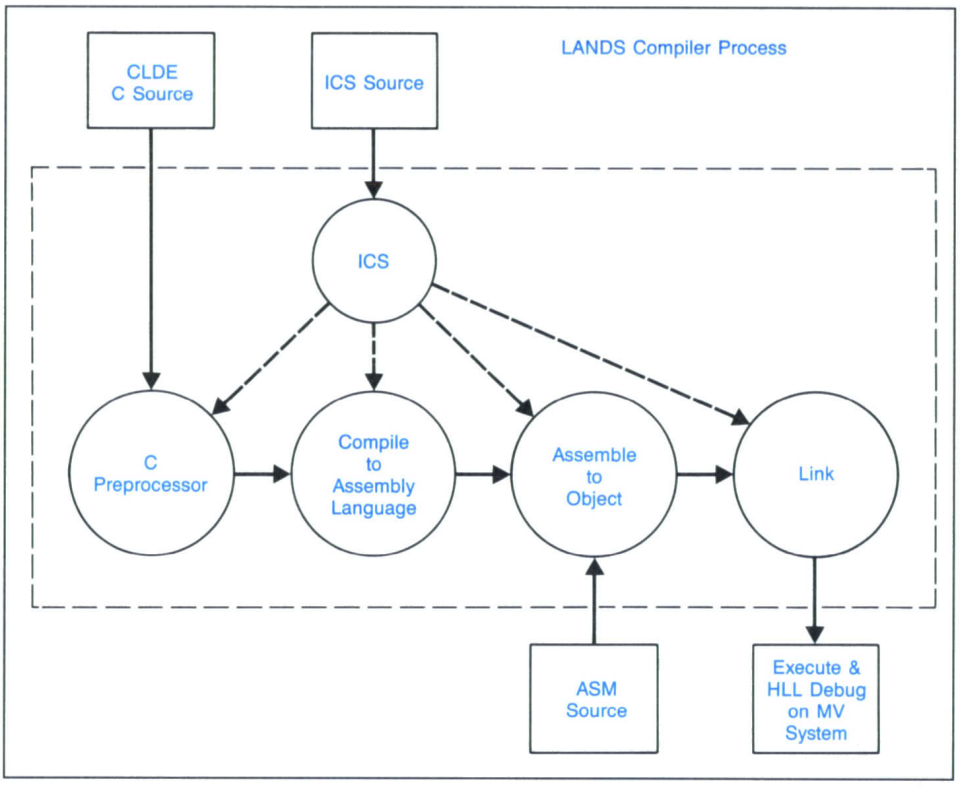
The CLDE is the same editor included in LANDS I products. New enhancements to CLDE include ANSI C compatibility.

68020 32-Bit Optimizing C Compiler

The 68020 C compiler is a true 32-bit compiler optimized to take advantage of the 68020 performance features including all the 68020's memory spaces and addressing modes. Key features of the 68020 C LANDS II compiler are:

- Kernighan and Ritchie Compatible
- ANSI C Standard Compatible
- Complete C Runtime Library Support
- Sophisticated Optimization Techniques
- Software and Hardware Floating-Point

Through sophisticated optimization techniques, generated code is compact and fast. For increased portability the additional features of the proposed ANSI C standards have been included as well as supporting the "de facto" Kernighan and Ritchie standard.



Integration Control System (ICS)

ICS was introduced as a unique tool in Tek's LANDS I product. The concept of an automated software/hardware integration tool is even more important in large applications. ICS has been enhanced, making it more powerful and more convenient. Once set up, it runs continuously in the background controlling the compilation, assembly, and linking processes.

Assembler and Linker

The 68020 assembler and linker are designed to support large program development. Key features with the assembler and linker include:

- Optimizes instructions and addressing modes
- Motorola compatible
- Recognizes all 68020/68881 instructions
- Nested plus recursive macros
- Conditional assembler
- Handles large programs

TekDB™—HLL Debug

The LANDS II source-level debugger called TekDB is integrated with the Multi-V 32-bit development system. The LANDS II compiler and assembler generate all the information required for source-level symbolic debugging. TekDB uses this information to provide the users of the Multi-V System with a fast and powerful debugging system and an easy-to-use visual interface. TekDB is a standard feature of the Multi-V Systems.

ORDERING INFORMATION

CLA6820 68020 C Development System (C compiler, assembler, linker, ICS, CLDE)	**$10**
OPTIONS	
Option 1C—VAX/ULTRIX	**+$9,990**
Option 1F—VAX/VMS	**+$9,990**
Option 1K, 1L—MicroVAX ULTRIX	**+$8,490**
Option 1M, 1N—MicroVAX VMS	**+$8,490**
Option 3S—Software Subscription Service	**+$1,000**
ASM6820 68020 Assembler, Linker ICS	**$10**
OPTIONS	
Option 1C—VAX/ULTRIX	**+$3,490**
Option 1F—VAX/VMS	**+$3,490**
Option 1K, 1L—MicroVAX ULTRIX	**+$2,990**
Option 1M, 1N—MicroVAX VMS	**+$2,990**
Option 3S—Software Subscription Service	**+$350**

V Systems 8- and 16-Bit Microprocessor Support Systems

- **8- and 16-Bit Real-Time Emulation**
- **Modular Universal System**
- **Expansion Capability**

To support the test and integration phases of a user's project, Tek offers V Systems—complete 8- and 16-bit microprocessor development systems. Modularity and universality are key features of the V Systems enabling them to be configured to meet your needs. Modular options include:

- Full Range of Microprocessor Support
- Program Memory—64K to 2 M bytes
- Trigger Trace Analyzer (TTA)
- Memory Allocation Controller
- Comunication Options

Real-Time and Transparent Emulation

Real-time emulation, standard on all 8- and 16-bit emulators, is accomplished by executing code on a processor identical in function to the one targeted for the prototype hardware. The emulator processor is run under the control of powerful debug software that allows control and tracing of the code's execution. This debug software does not need to be linked into your code or use any of your memory or interrupt lines. Tek's superior emulators allow your code to execute in real time, with no wait states inserted or clock pulses stretched. This means the emulator is fully transparent to the user, therefore, you do not spend time "working around" the development system.

TTA Captures Real-Time Events (standard with V Systems)

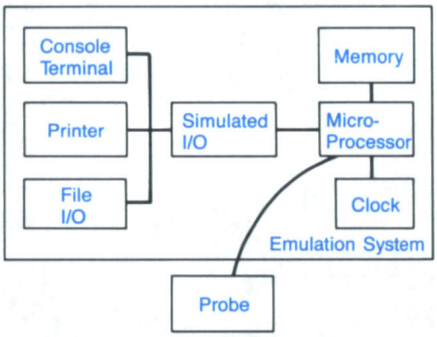
A powerful option to Tek emulators is the Trigger Trace Analyzer (TTA), which uses a high-speed trace buffer to capture real-time software and hardware logic events, with the prototype running at the design's full specified operating speed. Multiple-word recognizers allow you to define sophisticated triggers when tracing code execution. And data qualification allows you to capture only the data you wish to see.

Three Modes of Emulation

The V-Systems enable you to incrementally integrate your prototype software and hardware. Starting with mode 0, you can do a majority of your software design without a prototype. Using Supervisor Calls (SVCs) to simulate I/O, mode 0 debug can begin long before actual hardware is available.

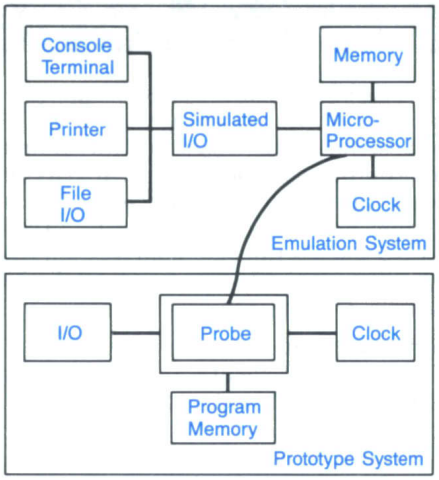
MODES OF EMULATION

Phased Emulation—Mode 0



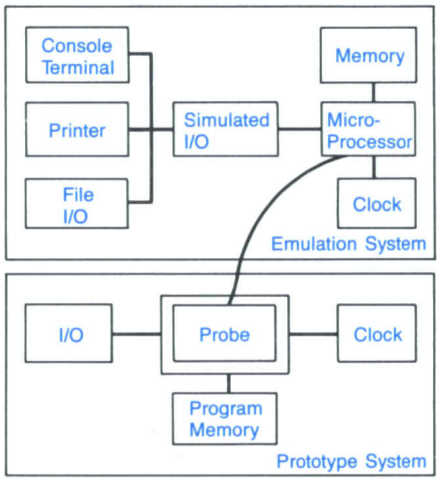
- No prototype hardware required
- Prototype I/O interactions are simulated

Phased Emulation—Mode 1



- Start software and hardware integration
- Program is transferred to prototype memory in steps

Phased Emulation—Mode 2



- Final test of software and hardware

Once prototype hardware is available, designers gradually move from using emulation system resources to using prototype resources (mode 1). The final step is to use all of the prototype resources (mode 2) to execute the program. Because of the transparent nature of Tek emulators, your prototype will reliably perform in mode 2 as it will in actual operation with the emulator disconnected.

ORDERING INFORMATION

V SYSTEMS

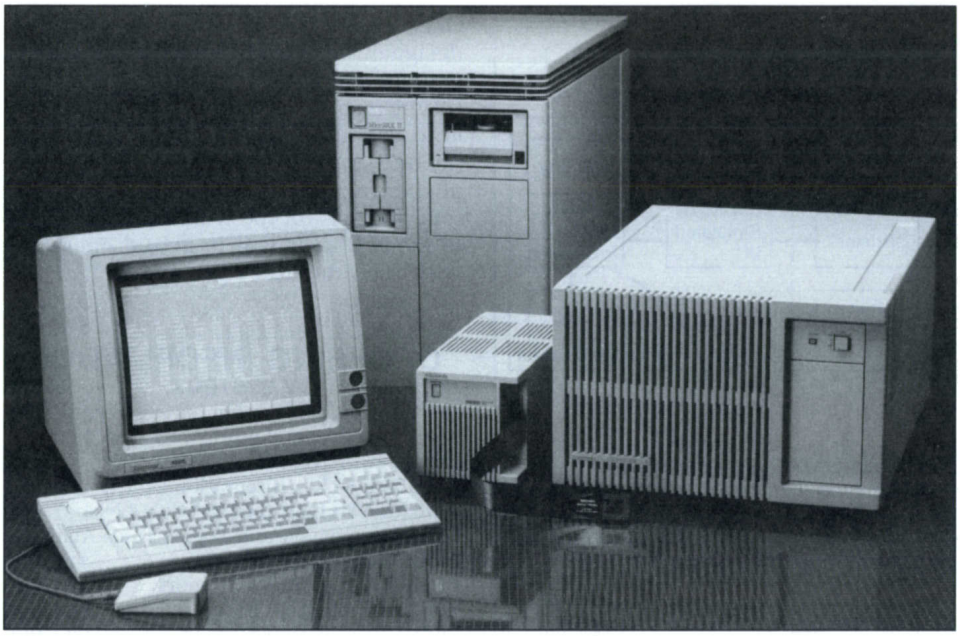
The V Systems are configured to integrate with an existing host computer, a VAX or MicroVAX computer or IBM PC AT/XT.

Included: 8540A Integration Unit, 8- or 16-bit emulation support (emulator and probe) with 128K-byte memory and Trigger Trace Analyzer.

VZ80 Emulation Support	**$12,500**
V68000A Emulation Support	**$24,900**
V68008 Emulation Support	**$24,900**
V68010 Emulation Support	**$24,900**
V6809 Emulation Support	**$12,500**
V80186 Emulation Support	**$24,900**
V80188 Emulation Support	**$24,900**
V8085 Emulation Support	**$12,500**
V8086 Emulation Support	**$24,900**
V8088 Emulation Support	**$24,900**

OPTIONS

Option 11—512K Bytes Total Memory	**+ $2,900**
Option 12—768K Bytes Total Memory	**+ $4,000**
Option 13—1M Bytes Total Memory	**+ $6,000**
Option 14—2M Bytes Total Memory	**+ $12,000**



Multi-V System

68020 Language Development

- **32-Bit Real-Time Emulation**
- **32-Bit Software Executers**
- **TekDB HLL Debug System**

32-bit microprocessors, like Motorola's 68020, present a level of complexity not encountered in previous 8- or 16-bit designs. To address these problems, Tektronix uses its experience in language tools and emulation systems to design the Multi-V System. The 68020 Multi-V System sets the industry standard for 32-bit development systems.

New Generation of Microprocessor Support

The 68020 Multi-V System consists of a family of tools to support software development through software/hardware integration and test. The Multi-V's unique architecture provides the industry's first true multi-user microprocessor development system enabling several emulators to reside in a single mainframe. Up to four mainframes can be integrated into one design environment, accessing eight tools through one user interface.

Multiple emulators can be controlled by a single user in a multiple microprocessor-based application or each emulator can be controlled independently by multiple users.

Other features of the Multi-V System are the Software Executer; an emulator; a Trigger State Analyzer; a memory system capable of up to 12M bytes; a high-speed industry standard local area network; I/O probes for cross-triggering function in multi-processor applications; TekDB, the most powerful microprocessor debug system available today; and C-LANDS II, a C Language Development System that enables you to take advantage of the full power of the 68020.

Software Executers

The Software Executer is a new tool providing a cost effective environment for early debug of software before prototypes are available. Code developed on the host computer is downloaded into the Multi-V's program memory system where it runs on the target microprocessor and FPU. Your program can then be verified with TekDB. If required, the Software Executers can be upgraded to full emulation by adding an emulator pod.

TekDB—State-of-the-Art Debug

As programs get larger and more complex, more powerful tools are needed for efficient program debug and verification. TekDB, a standard feature of the Multi-V Systems, is an enhanced version of the LANDS I HLL debugger. Key features of TekDB include virtually unlimited numbers of software breakpoints, complex breakpoint qualification, source code tracing, and complete control of display information. TekDB's powerful breakpoint qualification allows events to be described in such a level of detail that you need not set up other breakpoints to "zero in" on the desired event.

68020 Emulation

Software/hardware integration has always been a complex task. Advanced microprocessors, like the 68020, add another level of complexity to the integration task.

Tektronix designed the 68020/68881 emulator system for the needs of large design teams developing large complex applications. For in-prototype testing of your software, real-time emulation provides the testing capability required for real-time applications.

Trigger State Analyzer

A built-in bus state analyzer offers you flexible event recognition, and qualified acquisitions for real-time analysis. It allows you to time your C or assembly language code for increased system performance. All analysis can be done without interruption of user code execution.

Local Area Networking Improves Flexibility and Performance

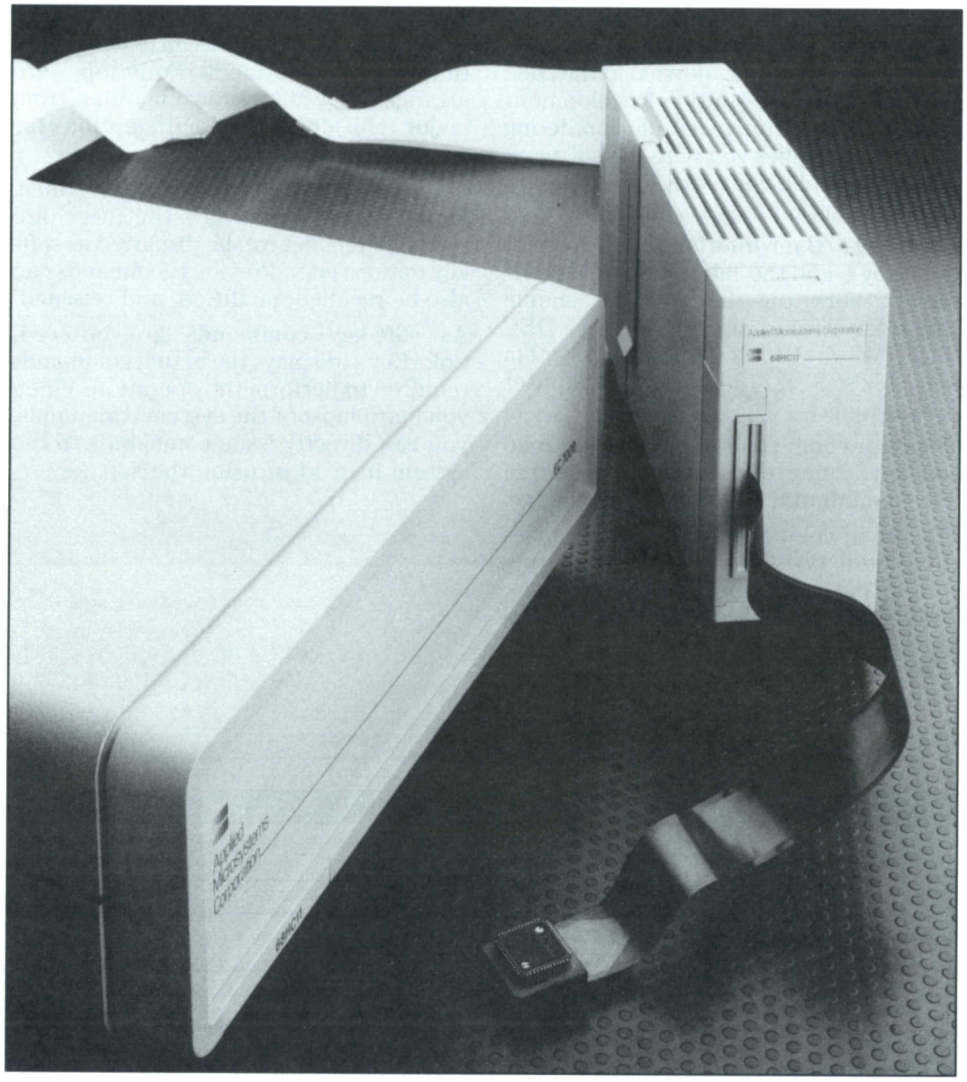
The Multi-V System's LAN Option enables your development systems to be connected directly to your network. The industry standard LAN is used: IEEE 802.3 electrical and mechanical connections, Ethernet frame formats and TCP/IP software protocol.

Support for the VAX Environment

The Multi-V System is tightly integrated into the VAX environment. Support for the entire VAX line from the VAXstation 2000 to the VAX8900, running on a VMS or ULTRIX operating system is offered.

ORDERING INFORMATION

MV6820 68020/68881 Support Systems	**$6,900**
OPTIONS	
Option 06—Software Executer	**+ $6,400**
Option 08—Emulator	**+ $13,500**
Option 10—Trigger State Analyzer	**+ $6,000**
Option 15—1M Bytes Memory	**+ $3,000**
Option 16—2M Bytes Memory	**+ $4,600**
Option 17—3M Bytes Memory	**+ $6,200**
Option 18—LAN plus Transceiver	**+ $2,000**
TekDB CONTROL SOFTWARE	
Option 1C—VAX/ULTRIX	**NC**
Option 1F—VAX/VMS	**NC**
Option 1K, 1L—MicroVAX ULTRIX	**NC**
Option 1M, 1N—Micro VAX VMS	**NC**
Option 3S—Software Subscription Service	**+ $300**



68HC11 Development System

- **High Performance—Low Cost**
- **Supports 68HC11 Family of Chips**
- **Easy to Use In All Four Models**

The E6811 System for the Motorola 68HC11 family of Microcontroller chips provides high performance emulation at a low cost for developing and integrating your software and hardware.

One System For All Development

The E6811 System designed for the 68HC11 family provides support for single-chip, expanded multiplexed, and special boot/test modes in a monolithic package.

Easy To Use

Controlled by an IBM PC XT/AT or compatible, user-friendly menu-driven software lets you control emulation at the push of a button. One special software feature is "tunneling." Saving time with fewer keystrokes, "tunneling" eliminates returning to the top-level menu to change functions. The E6811 Learning Guide, and on-line assistance let you begin using your E6811 immediately.

System Features

- 64K No-Wait State Memory
- Selective Tracing
- Register Tracing
- 16 Hardware Breakpoints With No Hardware Add-ons
- Power-up Diagnostics
- Counter/Timer Preservation With Emulations Stopped

Analysis Features

- Real-time Bus Acquisition
- Non-stop Execution
- 1024 Line Trace Buffer
- Before, Center, or After Trigger Qualifications
- Symbolic Debug
- Disassembler
- External Trigger In/Out Lines

Software Support

- Cross Assembler
- In-line Assembler
- Linker/Librarian
- TekHex, Motorola, and Microtec Object Format Support

ORDERING INFORMATION

E6811 68HC11 Emulation System **$9,600**

OPTIONS

Option 1Y—IBM PC Assembler **+ $750**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 50 Hz.
Option A5—Switzerland 220 V, 50 Hz.

Design Environments

- **Multiple Hardware Platforms**
- **ULTRIX/VMS/PC DOS Support**
- **Integrated Communications Packages**

To support your engineering environment, Tektronix has tailored tools for working in many different environments. By supporting the VAX family from VAXstation through VAX 8900 on both VMS and ULTRIX, and the IBM PC, you can choose the environment that best fits your needs.

Tek/DEC Software Compatibility

Tek offers powerful high-level language tools, both C and Pascal LANDS packages, and many popular assemblers on Digital Equipment Corporation's VAX series of computers using the VMS- or ULTRIX-based operating systems. This Tek/DEC combination gives you a powerful series of options when configuring your design environment.

You can run Tek software development tools on the VAX to produce executable object code, and easily download the code to a V8, V16, or Multi-V Development System to perform emulation/debug tasks. Tek supplies you with the software needed to make your VAX/Development System function as a turnkey system.

ColorKey+ User Interface

ColorKey+ and the Tek color graphics terminals work together to give simple single-keystroke access to the DEC VAX/VMS or ULTRIX operating system and Tek's 8 & 16-bit microcomputer design tools.

The color coding and graphically defined soft keys guide you through the system with a minimum of effort or knowledge.

The use of color and soft keys minimizes the time it takes to learn the operating system and emulation/debugging system. Soft keys simplify command entry and minimize keystrokes.

Soft-key labels appear on the bottom of the screen and change as different operations are performed. Functions are arranged in a hierarchical manner, from major tools down to specific options for selected commands.

ColorKey+ is an intelligent interface. Parameters entered by the user are remembered and can be displayed as soft-key options later. Previous commands can also be recalled, modified, and reissued.

As soft-key commands are entered, ColorKey+ displays the actual commands required to perform the operation. When you learn most of the system commands, you can directly issue commands to the system instead of using the soft keys.

SOFTWARE SUPPORT

	VAX/VMS	VAX ULTRIX/UNIX	IBM PC	EMULATION
68020/68881	Assembler, C LANDS II A LANDS I (Ada)	Assembler, C LANDS II		✓
68HC11			Assembler	✓
68000	Assembler, C LANDS I, Pascal LANDS I	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
68008	Assembler, C LANDS I, Pascal LANDS I	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
68010	Assembler, C LANDS I, Pascal LANDS I	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
8086	Assembler, C LANDS I, Pascal LANDS I, PL/M	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
8088	Assembler, C LANDS I, Pascal LANDS I	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
80186	Assembler, C LANDS I, Pascal LANDS I	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
80188	Assembler, C LANDS I, Pascal LANDS I	Assembler, C LANDS I, Pascal LANDS I	Assembler, C & Pascal Compilers	✓
1750A	Assembler, A LANDS I (Ada)			✓
Z80	Assembler, Pascal, C Compiler	Assembler	Assembler, C & Pascal Compilers	✓
8085	Assembler, Pascal, C Compiler	Assembler	Assembler, Pascal Compiler	✓
6809	Assembler	Assembler	Assembler	✓
Z8001/2	Assembler			✓

A complete software integration environment from Tektronix. Products shown from left are the V1750S Software Integration System, Digital's VAXstation 2000, and Ada Language Development System (A LANDS I).

Support for Aerospace/Defense Applications

- **Real-Time Software Testing in the Target System**
- **High-Order-Language Development Systems; Ada®**
- **VAX Family Host Support**
- **Worldwide Service and Support**

The use of microprocessors in military applications has mushroomed in the past few years. Military applications usually have strict reliability and environmental requirements that prevent the use of commercially popular microprocessors. Tek is addressing the need to support microprocessors used in military applications by offering support for the following processors: Z8000 including the 10-MHz Z8001B and Z8002B, and MIL-STD 1750A processors including the F9450, MDC281, PACE1750, Delco M-371, Mikros MKS1750, Tracor RH1750, and the 32-bit 68020.

MIL-STD 1750A Background

In an effort to control the spiraling cost of developing software, the military community has instituted several standardization programs. One of these, MIL-STD 1750A, was developed for the United States Air Force and defines the standard 16-bit processor to be used in all embedded weapons systems. MIL-STD 1750A standard specifies the Instruction Set Architecture (ISA) but not the physical, electrical, or performance characteristics of the processor. This allows processors to be implemented as several boards, a single board, or a microprocessor chip. Since the ISA is the same, application software can be transported from one processor to another without modification.

MIL-STD 1750A Support System

The Tektronix 1750A support system includes tools for developing and debugging software for embedded applications. The package includes a Tektronix assembler/linker system for software development and a full-function emulation system for testing the software with or without the target system.

The 1750A assembler/linker package provides all of the functions to support machine-level program development. The assembler supports either the MIL-STD 1750A instruction mnemonics or the IEEE version. The package can be hosted on the DEC VAX, MicroVAX, and VAXstation Series with VMS.

For embedded applications requiring a real-time operating kernel, Tektronix is offering the Hunter-Ready VRTX/1750 and VMX/1750 R&D packages. VRTX and VMX are off-the-shelf software components that can be used directly in the embedded system to coordinate real-time tasks. These systems are available in EPROM and computer media to be used directly in the target environment.

The MIL-STD 1750A emulator supports the unique requirements for integrating software into the target environment. The emulation system can be used to test software written in assembly, or in a high-order language such as Ada, JOVIAL, or CMS-II. A series of probe adaptors are available for connection into the target processor environment including an in-circuit probe for the F9450 microprocessor. These probe adaptors can be used to connect the emulator to a chip socket (F9450), a board, a bus, or to the CPU's mechanical enclosure.

Performance Semiconductor PACE1750 Processor Support

Tektronix has expanded its MIL-STD 1750A program by announcing V1750A Software Integration System support for the Performance Semiconductor PACE1750. Testing and verification was completed using a 20-MHz version of the PACE1750. For support of the 30 and 40-MHz versions, contact your local sales engineer. Probe options include the bus probe, and socket probe for the DIP package.

McDonnell Douglas MDC281 Processor Support

Tektronix has expanded its MIL-STD 1750A program by announcing V1750A Software Integration System support for the McDonnell Douglas MDC281 processor. Verification testing with the V1750A and the MDC281 was conducted at the McDonnell Douglas Microelectronics Center in St. Louis, Missouri.

The Tektronix V1750A Software Integration System provides the mechanism to transfer the run-time software from the mainframe into the MDC281 target system. This allows the software to be executed in real time, right in the target environment. The V1750A provides control and monitoring capability, while execution is progressing in real time. Both the 15-MHz and 20-MHz versions of the MDC281 are supported in real time.

Other MIL-STD 1750A Processors

In addition to the MDC281 and PACE1750, the V1750A also supports the Fairchild F9450, Delco M-371, Mikros MKS1750, and the Tracor RH1750.

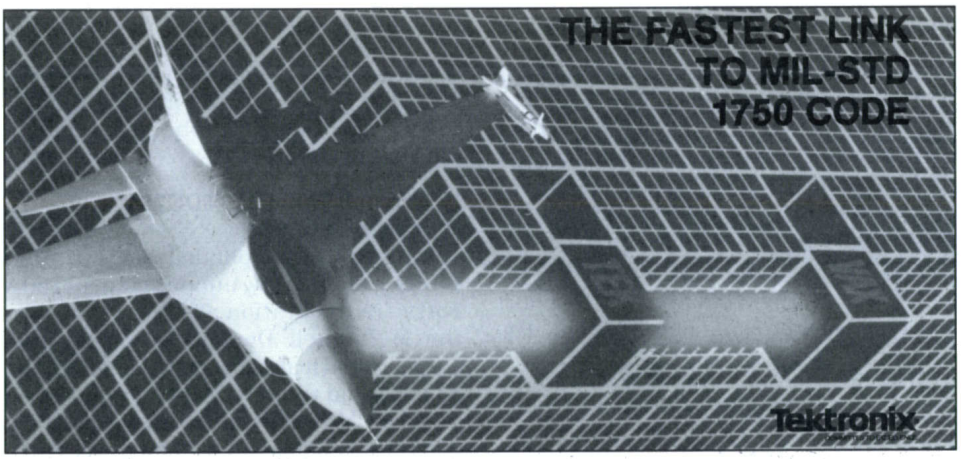
1750A Software Executer, 88M1750

When the target hardware isn't available, the 1750A Software Executer (SWE) can be used in its place. The 1750A SWE provides a MIL-STD 1750A compliant environment for testing and debugging software. Programs can be loaded and tested with the SWE processor before they are transferred into the target environment. I/O systems on the target can be simulated by using SVC calls to access host resources like file systems and peripheral hardware. Several MIL-STD 1750A options are supported by the SWE including expanded memory and memory block protect.

The 1750A SWE resides in the V1750A mainframe and can access up to 1 Megaword of internal memory for program execution. The V1750A can be located at the host site and accessed remotely. This means the SWE is available to other users in a multi-user host environment without moving the system. A software boot-up function also provides control so the V1750A can be restarted remotely.

68XXX Support Systems

In-circuit support is available for the 68000 family of processors including the 68000, 68008, 68010, and the 32-bit 68020. These systems provide a test and



debug environment for embedded software. Run-time software can be executed on the target hardware for the 68xxx family; or on a software executer for the 68020.

The 68000, 68008, and 68010 support is available in the V-System configuration which is based on the 8540A mainframe. The 68020 is supported in the new MV6820 configuration. Besides the high-speed ethernet connection to the host, each MV6820 can be configured with up to two separate 68020 probes so multiple processor environments can be supported. MV6820 systems can also be cascaded together to support up to eight microprocessors at one time.

Z8000 Support Systems

Z8000 processors are used in a wide variety of military applications, and are currently available to meet military reliability requirements like MIL-STD 883 screening.

Tektronix supports both the Z8001 segmented version, and the Z8002 non-segmented versions of the processor. An assembler/linker system is available to support machine language programming requirements. Both of these software systems are supported on VMS for the VAX family of hosts.

The emulator supports in-circuit probes for either the Z8001 or Z8002 microprocessors. Both the 10-MHz Z8001B and Z8002B are supported in real-time with no-wait states. The emulator system provides trace, break-point, and memory substitution in the actual target environment.

MIL-STD 1815A (Ada) Support

Ada has been mandated by the Department of Defense to be used as the single High Order Language (HOL) used in all mission-critical applications. The effect of this mandate is to reduce the escalating cost of developing and maintaining software for military applications. These software costs are currently estimated at $10 billion, and by 1990, they will triple to $30 billion. Ada is also being used for commercial applications, especially in the European electronics industry.

Ada is not just another programming language and incorporates many characteristics that support modern software engineering principles. Tektronix is making a significant commitment to developing Ada support for its customers. An Ada language system is available to support MIL-STD 1750 and 68020 applications. This system is modeled after the Tektronix LANDS software development environment. Your Tektronix Sales Representative can give you the details.

ORDERING INFORMATION

V1750A Software Integration System	$33,500
Includes: 64K Word Program Memory	
OPTIONS	
Option 3A—PIA with Flying Leads, Clips	+ $750
Option 3B—PIA with Flying Leads, Pigtail	+ $650
Option 3C—PIA Euro-Card Connector	+ $750
Option 3D—PIA, F9450 Probe without expanded memory	+ $1,500
Option 3E—PIA, F9450 Probe with expanded memory	+ $2,000
Option 10—256k bytes Total Memory	+ $1,000
Option 11—512k bytes Total Memory	+ $2,900
Option 12—768k bytes Total Memory	+ $4,000
Option 13—1M bytes Total Memory	+ $6,000
Option 14—1M Word Total Memory	+ $12,000
88M1750 Software Execution Unit	$8,500

Services

- **Software Subscription Service**
- **Warranty—plus Service Plans**

After purchasing Tektronix products, extensive support is available.

SOFTWARE SUBSCRIPTION SERVICE

The Tektronix Software Subscription Service (SSS) automatically provides new releases of licensed software products as well as associated updates to software documentation.

Availability

Software Subscription Service is available on most software items.

Product Updates

New software releases are sent out as product updates occur. This program allows customers to maintain their equipment at the latest software revision level.

Applications and Information

Customers must identify a person or department responsible for receiving software updates and for maintaining the software's integrity.

SSS should be purchased for all CASE software because of possible product interaction.

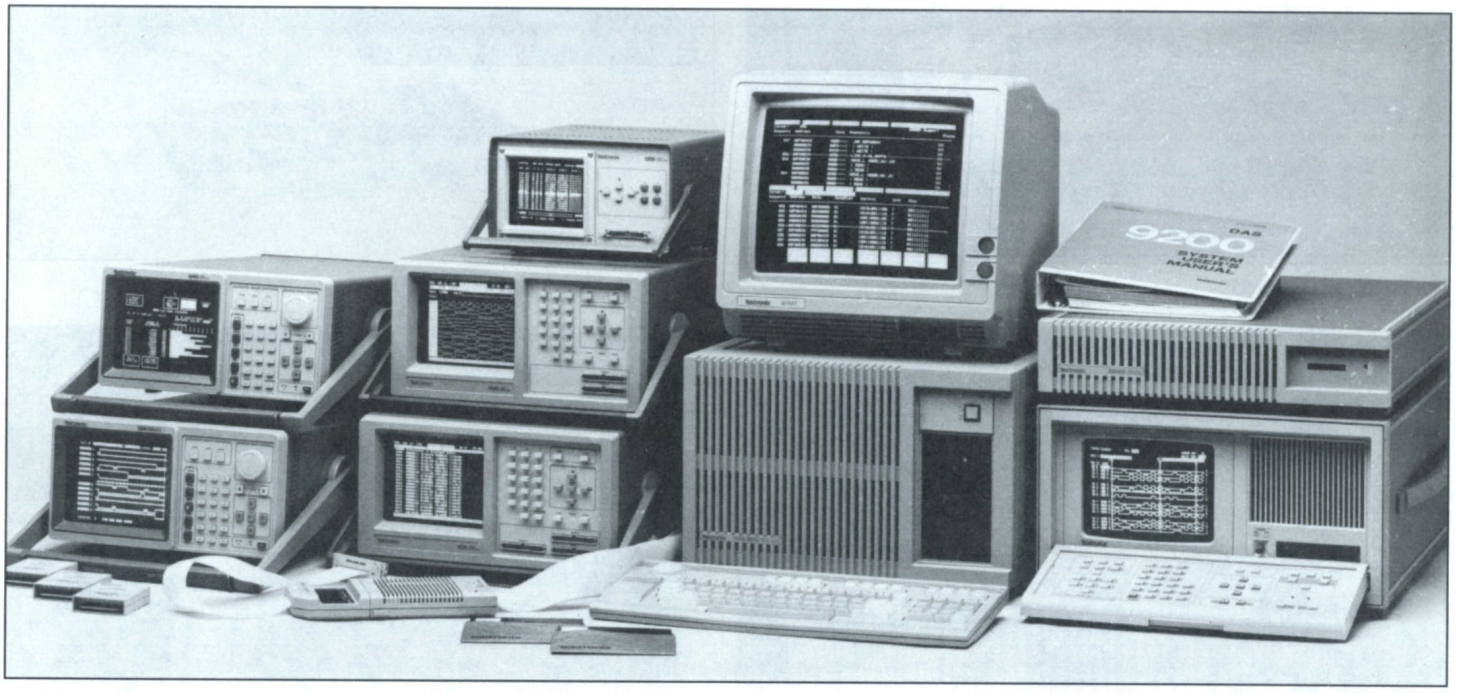
WARRANTY-PLUS SERVICE PLANS

WARRANTY-PLUS is available on most hardware items.

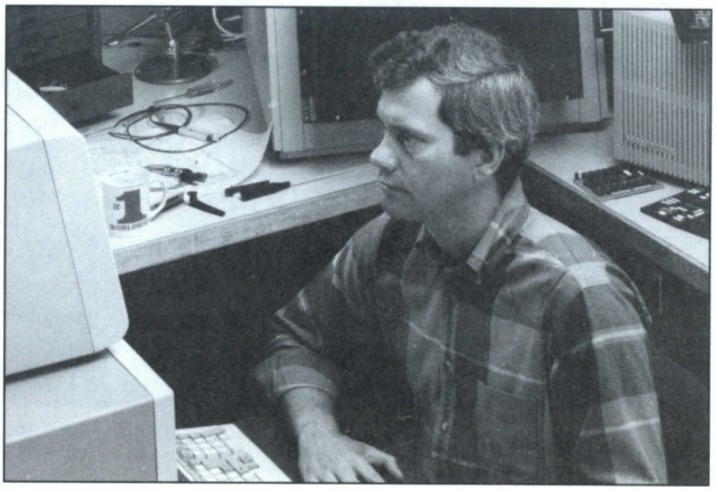
LOGIC ANALYZER PRODUCTS

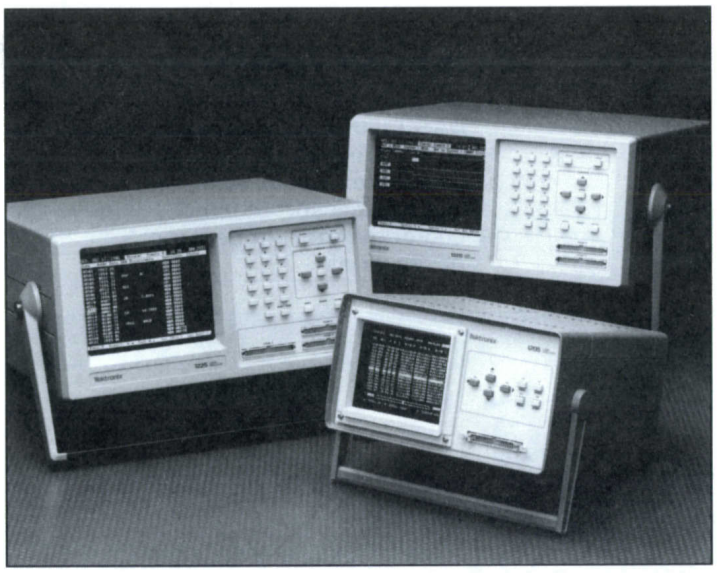
CONTENTS

DAS 9200 Digital Analysis System 106
DAS 9100 Digital Analysis System 115
1200 Series Logic Analyzers 118
300 Series Logic Analyzers 126
Microprocessor Support 128
Logic Analyzer Probes and Accessories 130

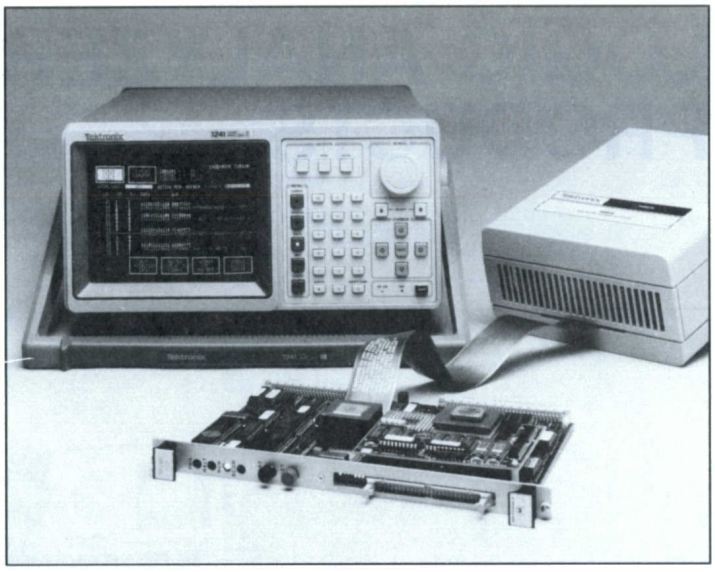


The Tektronix Logic Analyzer family includes the DAS 9200, DAS 9100, 1240/1241, 1220, 1225, and the 300 Series Logic Analyzers (not shown).

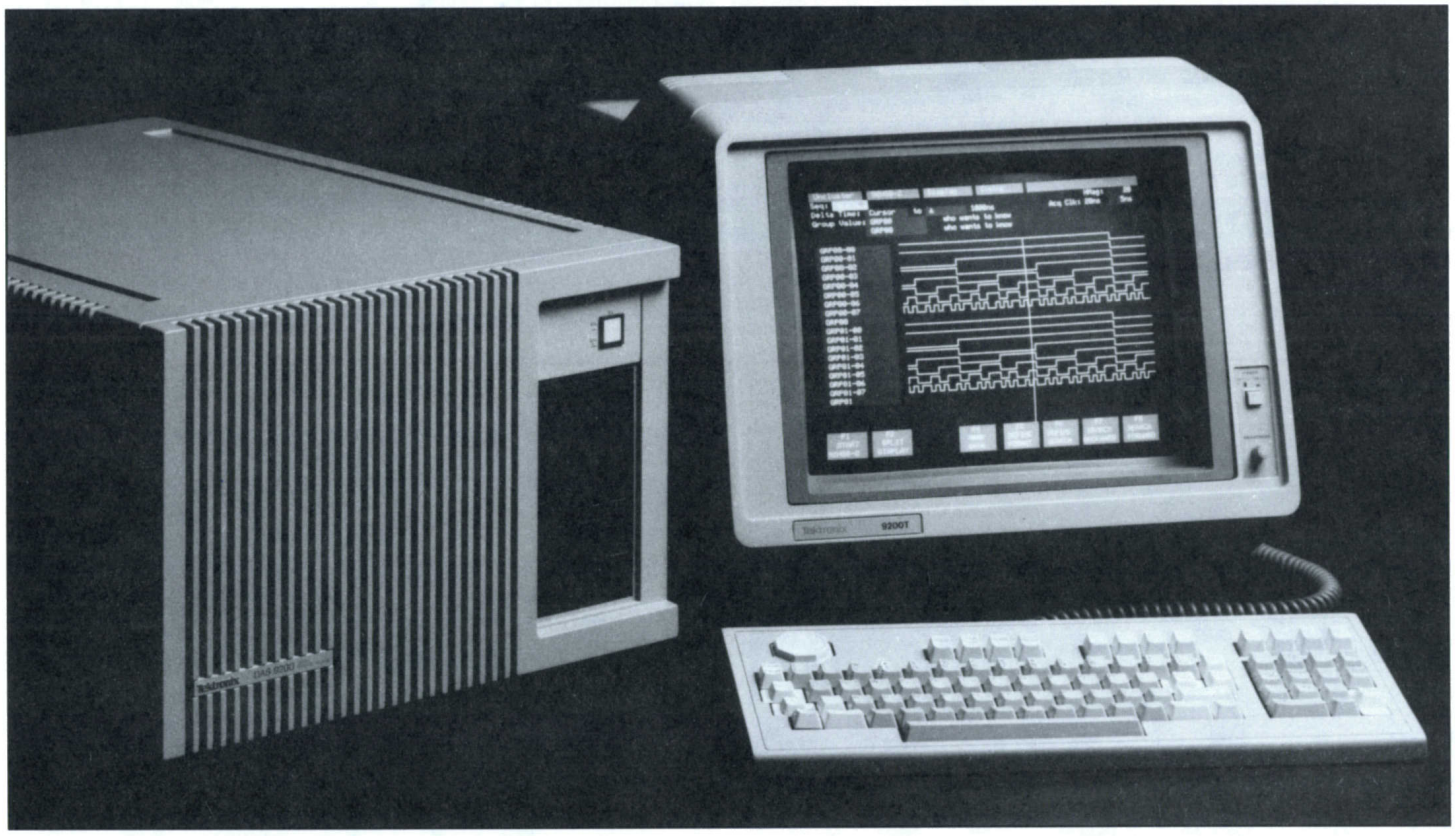




1225, 1220, and 1205



1241 with 68020 Personality Module



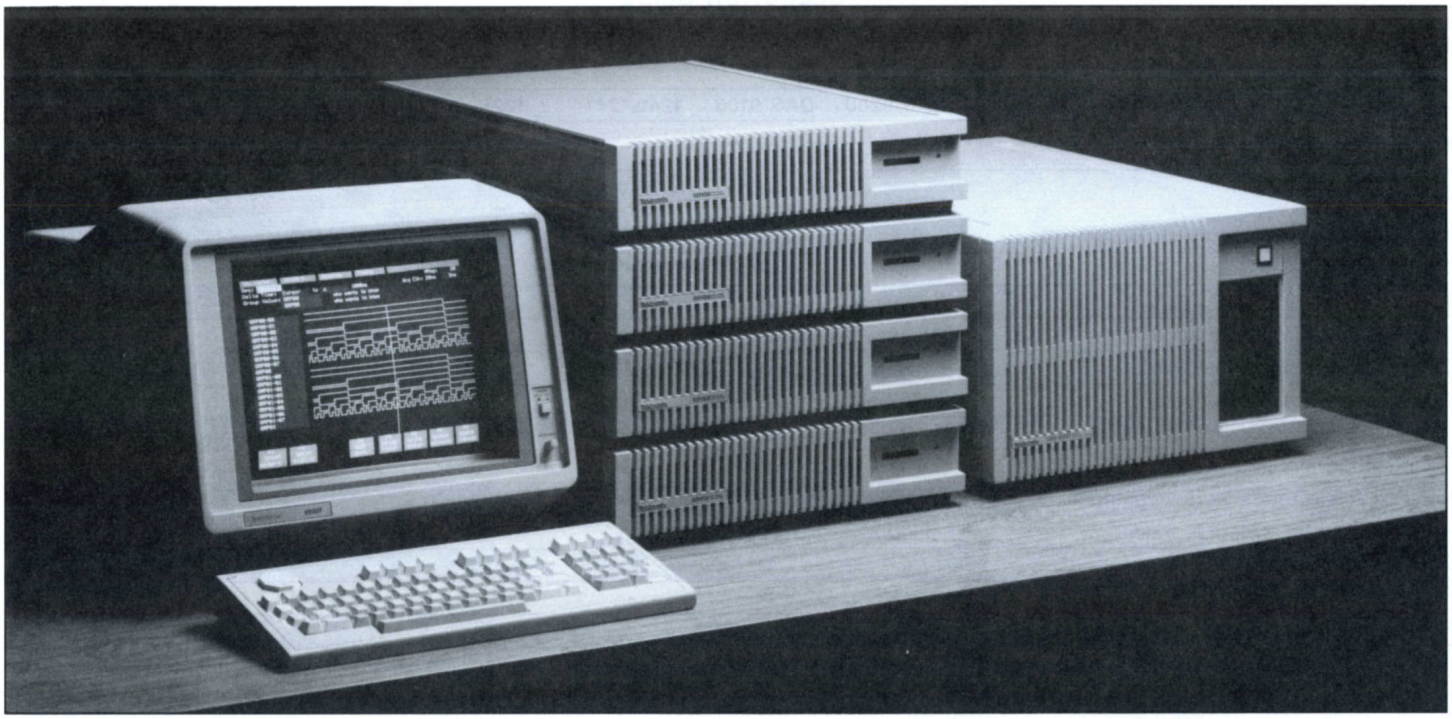
DAS 9200. The DAS 9219 mainframe and the color display form the cornerstone of the 9200 Series.

SELECTION GUIDE

For more information on a specific model, refer to the description on the following pages, or contact your Tektronix Sales Engineer.

Application/Feature	DAS 9200	DAS 9100	1240/1241	1225	1220	1205	318A	338
Hardware Analysis								
Asynchronous acquisition rate (MHz)	20,200 2,000	10,25 100,660 2,000	100	100	100	100	50	20
Color display	✓	✓	✓					
Modular	✓	✓	✓					
Simultaneous state/timing acquisition	✓	✓	✓	✓	✓			
Maximum acquisition channels	540	104	72	48	32	24	16	32
Maximum pattern generation channels	1792	384						
Glitch capture	✓	✓	✓	✓	✓	✓	✓	✓
Edge recognition	✓		✓					
Acquisition/reference memory compare	✓	✓	✓	✓	✓		✓	✓
Easily transportable storage media	Floppy	Tape	Pack					
Trigger input and output	✓	✓	✓	✓	✓		✓	✓
Screen hard-copy capability	✓	✓	✓	✓	✓	✓	✓	✓
Ruggedized mainframe			✓				✓	✓
Software Analysis								
Synchronous acquisition rate (MHz)	20,200	10,25 100,330	50	20	20	9	50	20
Trigger on complex program flow	✓	✓	✓	✓	✓		✓	✓
Data qualification	✓	✓	✓	✓	✓			
Microprocessor mnemonics	✓	✓	✓	✓	✓	✓		
Multiple microprocessor support	✓							
Time stamp	✓							
User-definable mnemonics		✓						
Performance analysis	✓		✓					
Serial data analysis to 19.2 kbaud							✓	✓
Hardware/Software Integration								
Multiple synchronous time bases	✓		✓	✓	✓			
Trigger arming	✓	✓	✓					
Time-aligned state and timing displays	✓	✓	✓					
Graph display	✓							
Demultiplexing	✓	✓	✓					
Programmable via RS-232C	✓	✓	✓	✓	✓		✓	✓
Programmable via GPIB	✓	✓	✓					
Remote control via master/slave		✓	✓					
See page:	106	115	118	122	122	124	126	126
Prices Begin At:	$8,970	$13,470	$4,500/$6,000	$5,395	$3,995	$2,495	*	$5,800

* *Contact your local sales office for information.*



Fastest digital analysis system in the world—DAS 9219 mainframe and color display with four 8-channel, 2 GHz 92HS8 modules.

DAS 9200 Series

Digital Analysis System

GPIB IEEE-488 Tek 9200 communication module 92C02 (mainframe option 2C) complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

The DAS 9200 expands on all the best features of the proven DAS 9100 line of digital analysis tools. Its modern architecture allows you to install only those data-acquisition and pattern-generation modules you need today, and then upgrade and expand as your needs grow. The high-resolution color display and a menu-driven interface make the instrument easy to learn and use.

The DAS 9219 mainframe and 9201T color display form the cornerstone of the 9200 Series. The mainframe supplies the 68010 CPU, 2M-byte system RAM, 20M-byte hard disk, 360k-byte floppy disk, three RS-232 ports, and 750-watt power supply, all standard.

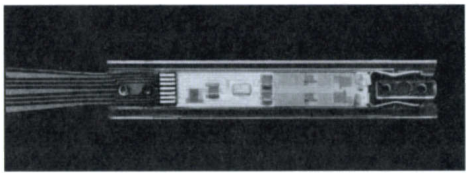
A variety of data-acquisition and pattern-generation modules are available. You choose the module type based on the number of channels, operating speeds, and analysis features required. Most modules allow you to increase channel width by adding expansion circuit boards. Depending on the module type, you can define a module to be up to 8 circuit boards wide. Refer to the DAS 9200 Performance Summary for an overview.

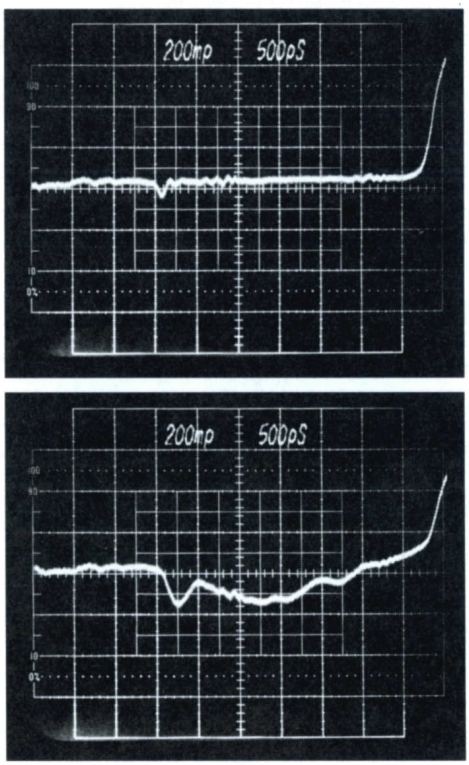
Any combination of data acquisition and pattern generation can be installed in the same mainframe. Modules can be set up to interact in real-time. For instance, two acquisition modules can be set up to run at different clock rates and still display time-correlated data. With 92A60/92A90 modules, this feature lets you debug multiple-microprocessor systems.

Fastest in the World

The 92HS8 acquisition module provides up to 32 channels at 2-GHz asynchronous sampling rates (500-ps sampling period). A fully expanded 9200 system supports five sets of 32-channel 92HS8s, for a total of 160 channels at 2 GHz.

The 92HS8 combines the timing resolution of an oscilloscope with the flexible triggering, glitch detection, memory depth, and channel width of a logic analyzer. It uses a new generation of high-performance probes with custom ICs in the probe tips. These probes provide high-impedance differential inputs and input capacitance of less than 1 pF to eliminate common-mode noise and circuit loading.





Comparison of the line distortion of the 92HS8 probe attached to a nominal 500-Ω test point on an ECL-based circuit (top), versus that of a typical 100-MHz probe.

Multitasking

The DAS 9200 allows you to define clusters of modules. A cluster is a set of modules designed to function independently of any other modules in the mainframe. If you define two clusters, you effectively have two analyzers; they can run simultaneously and independently. For example, if you are babysitting a prototype while looking for an intermittent failure, you can define one cluster of modules to monitor the prototype and use the remaining modules in the DAS 9200 for other problems.

Expansion

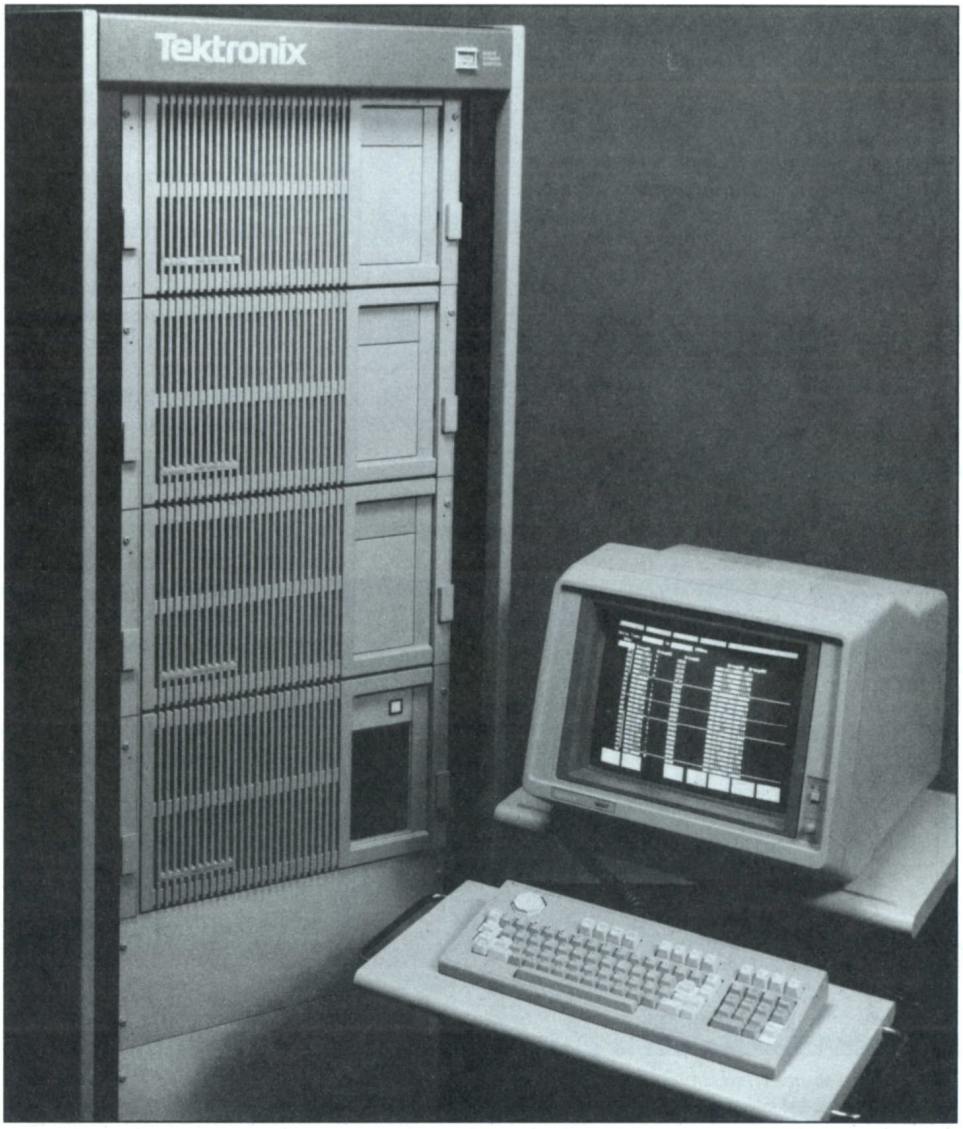
Up to three expansion mainframes (DAS 92E9) can be connected to the DAS 9219 for a total of 28 slots. The DAS 92E9 expansion mainframe has eight card slots, a 750-watt power supply, a backplane board, and an expansion slave board in slot 0. It has no CPU, disks, system memory, or display. Up to three expansion mainframes can be connected in daisy-chain fashion.

To connect an expansion mainframe to the DAS 9219 or to another expansion, the top slot of the lower mainframe (slot 8) must contain an Expansion module or combination Expansion/GPIB module. This module connects with cables to the slave board in slot 0 of the expansion mainframe.

The maximum configuration yields 28 card slots: six slots in the base mainframe; seven slots each in the first and second expansions, and eight slots in the third expansion mainframe. DAS 9200 systems with two or more expansion mainframes must be rack mounted.

Ease of Use

The power of the DAS 9200 doesn't come at the expense of ease-of-use. All operations are menu-controlled via a high-resolution color display. Menus are grouped into Setup, Display, and Utility functions, thus keeping logical operations together. Throughout the menu structure, a field-specific, on-line, help system is available to guide your selections and keep you focused on the problems instead of the tool.

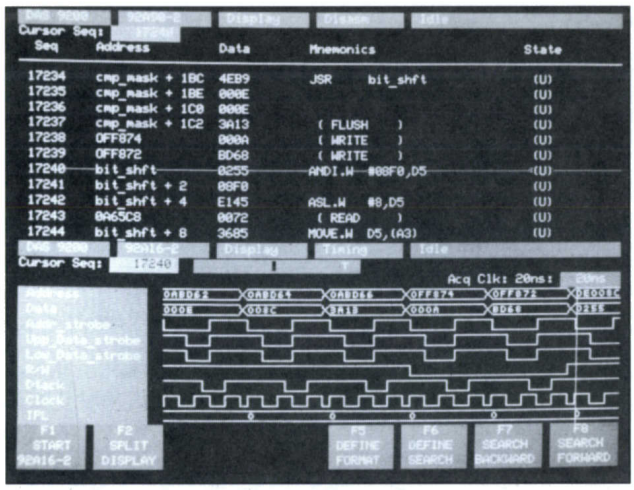


Up to three expansion mainframes can be connected to the DAS 9219 mainframe, in daisy-chain fashion, for a total of 28 slots. In an Automated Test Environment, the DAS 9200 can be set up and controlled over either RS-232 or GPIB interfaces.

DAS 9200 PERFORMANCE SUMMARY

Card Name	Type	Speed	Maximum Channels per Card	Maximum Channels per Module	Maximum Channels per System	Memory Depth	M/F Slots Req'd
92A16/92A16E	Acquisition	200 MHz	16	96	384	4K	1
92A60	Acquisition	20 MHz	60	60	360	32K	2
92A90	Acquisition	20 MHz	90	90	540	32K	2
92HS8/92HS8E	Acquisition	2 GHz	8	32	160	8K	2 (2/32 ch)
92S16	Pattern Generator (algorithmic)	50 MHz	18*1 32*2	270*3 480*4	936*3 1664*4	1K	1
92S32	Pattern Generator (sequential)	50 MHz	36*1 64*2	288*1 512*2	1008*1 1792*2	8K 4K	1 1

*1 *Using P6464 9-channel pattern-generator probes.*
*2 *Using P6463 16-channel pattern-generator probes.*
*3 *92S16 controlling multiple 92S32s; P6464 probes.*
*4 *92S16 controlling multiple 92S32s; P6463 probes.*

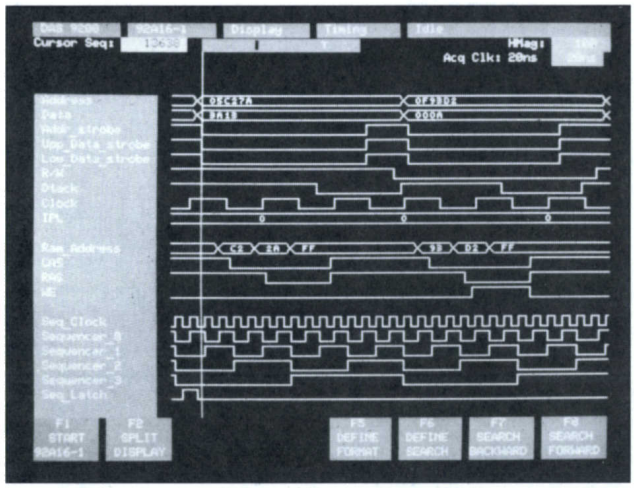


This split-screen display shows data acquired simultaneously from a microprocessor (using 92A90) and from bus timing signals (using 92A16).

Hardware Timing Analysis

Configured with 92A16 Data-Acquisition Modules, the DAS 9200 makes an unbeatable tool for timing analysis and hardware integration. With the bus-values display that lets you monitor the activity on dozens of channels, and the ability to display correlated timing diagrams of nonsynchronized circuit elements, you can perform such tasks as:

- Monitor a state machine synchronously
- Monitor a state machine synchronously and surrounding circuits asynchronously
- Synchronously acquire transactions on both sides of dual-ported RAM
- Sample data from different parts of a circuit at different synchronous rates
- Identify which functional block is central to a problem

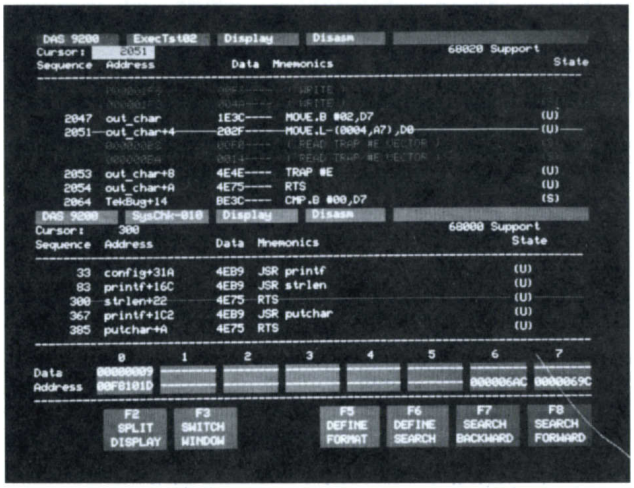


This display shows time-correlated data from a microprocessor, the dynamic RAM controller, and high-speed logic independent of the microprocessor bus.

Hardware/Software Integration

Configured with both 92A16 and 92A60/90 modules, the DAS 9200 helps you evaluate the complex interactions between hardware and software. It lets you display disassembled microprocessor activity on the same screen as high-resolution timing information, with true time-correlation of all data. You can use the acquisition modules to:

- Pinpoint logic timing problems that occur relative to specific software events
- Evaluate dynamic memory and peripheral timing under a variety of conditions
- Perform high-resolution timing measurements of any circuitry interfaced to a microprocessor



This display shows data acquired simultaneously from two microprocessors using separate 92A60/92A90 modules. The display in the lower window includes register deduction.

Software Analysis

Configured with 92A60 and 92A90 Data-Acquisition Modules, the DAS 9200 lets you monitor up to six microprocessors at once and offers the following features:

- Multiphase clocking handles the most complex microprocessor clocking schemes
- State-driven triggering lets you define and branch to any of 16 states for precise trigger placement
- Exceptionally deep (32K bits/channel) memory lets you see and solve your problem with a single acquisition
- High-resolution timestamp accurately time-correlates data from multiple microprocessors

Microprocessor Support

The 92DM family of microprocessor-support products provides display and setup software and single-connection probe adaptors for most popular microprocessor packages. See page 128 for ordering information.

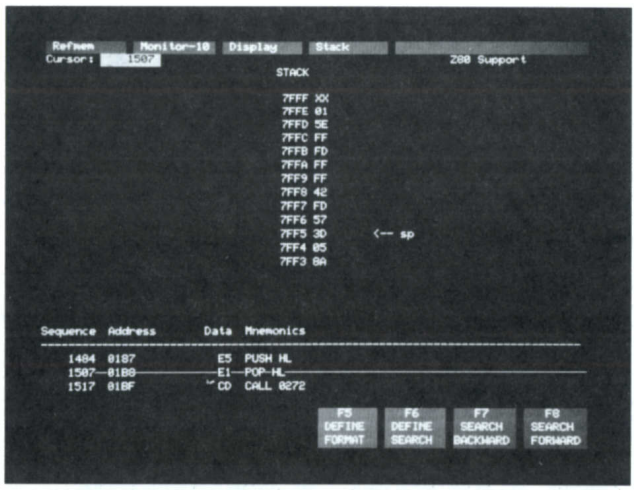
The 92DM support of most microprocessors on the DAS 9200:

- Lets you integrate multiple microprocessors by acquiring all bus transactions simultaneously and displaying time-correlated disassembly of any two micros on the screen
- Deduces register contents from acquired data and displays registers simultaneously with disassembly
- Simulates stack contents in a Stack display that is continually updated as you scroll through disassembly
- Outlines program flow with Subroutine Trace Mode
- Shows most recent variable values within a block of addresses
- Offers symbolic debug by using address symbols for display and triggering.

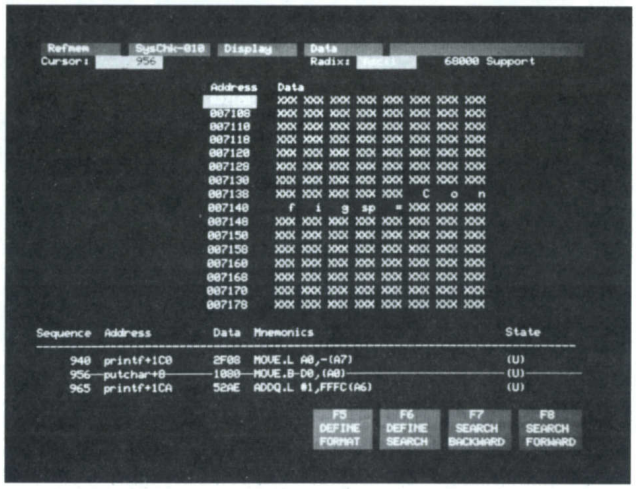
Disk-based mnemonics and single-connection probe adaptors make DAS 9200 microprocessor support versatile and easy to use. Refer to page 128.

Performance Analysis

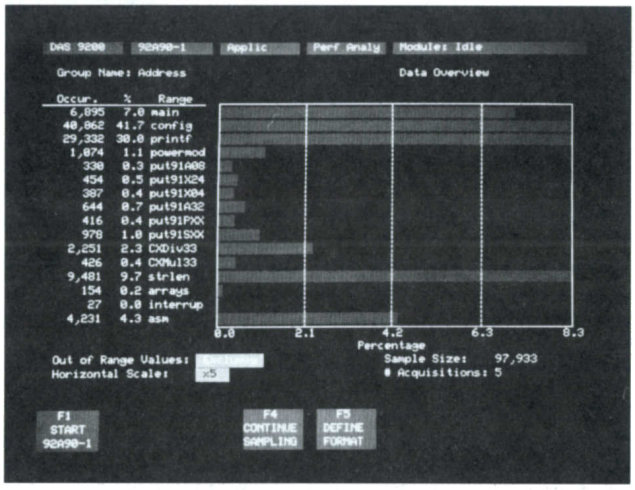
Both 92A60 and 92A90 Data-Acquisition Modules provide the DAS 9200 with Performance-Analysis capabilities that let you monitor software activity in real time without the delays and compromises of breakpoints, wait states, or debug code. And to put it all together, the graphical display makes the information easy to access and easy to interpret.



Stack simulation display. Problems like stack overflow of subroutines that don't correctly restore the stack pointer can be quickly identified by watching a continually updated stack model as you scroll through disassembly.



Data Display lets you see how variable space is modified by your software.



Performance Analysis gives a graphic report on the activity of your code. This display shows an overview of the activity percentages of 16 different subroutines.

The DAS 9200 personal verification system supports application-specific IC (ASIC) functional verification, analysis, and debugging.

ASIC Prototype Verification

By building on the foundation of the DAS 9200, Tektronix makes ASIC prototype verification a simple, reliable, turnkey process.

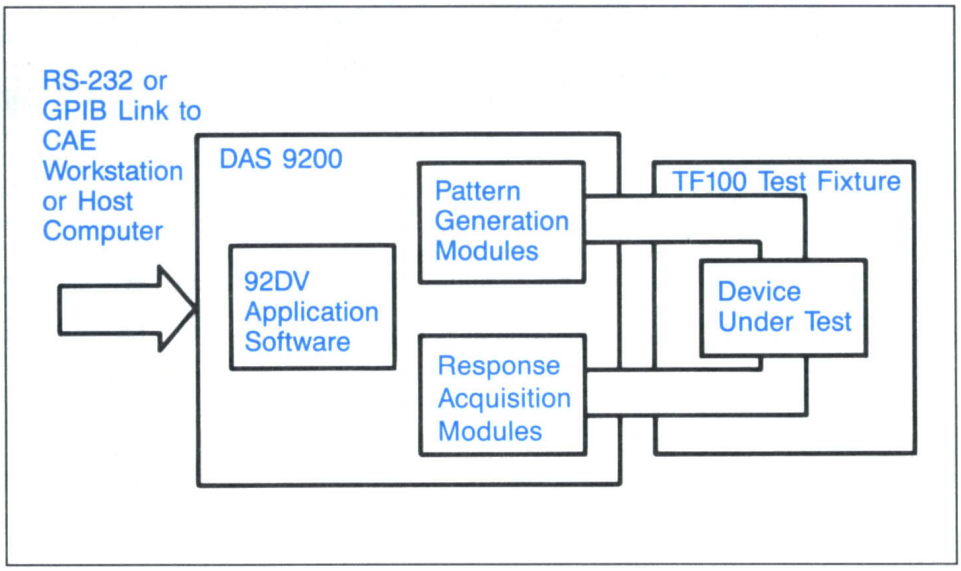
The DAS 9200 ASIC verification system is intended specifically for ASIC designers who need to evaluate first devices from the vendor, determine whether they work, and most importantly, decide whether to release the part for volume production.

The system features 50-MHz test rates, 1-ns edge placement, 5-ns minimum pulse widths, ±1.6-ns maximum skew, plus 3.0/0-ns setup/hold times. Other systems promising high resolution without the DAS 9200 complementary high accuracy are incapable of such precision.

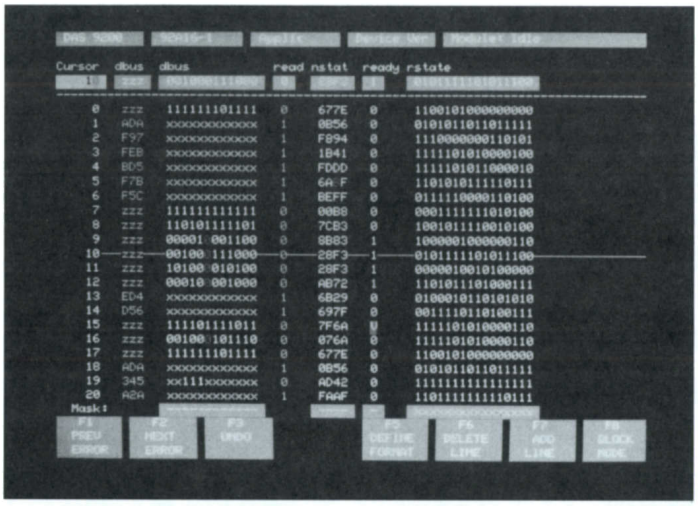
ASIC designers can download the same test vectors developed during ASIC design, using translators that automatically reformat vectors from popular simulators, including CADAT, Daisy, Mentor, GenRad Hilo-3, Teradyne LASAR, and Valid.

The system applies the test vectors to the ASIC device, then compares the expected response (predicted by the logic simulator) to the actual response of the device. Test results can be conveniently displayed in several different formats.

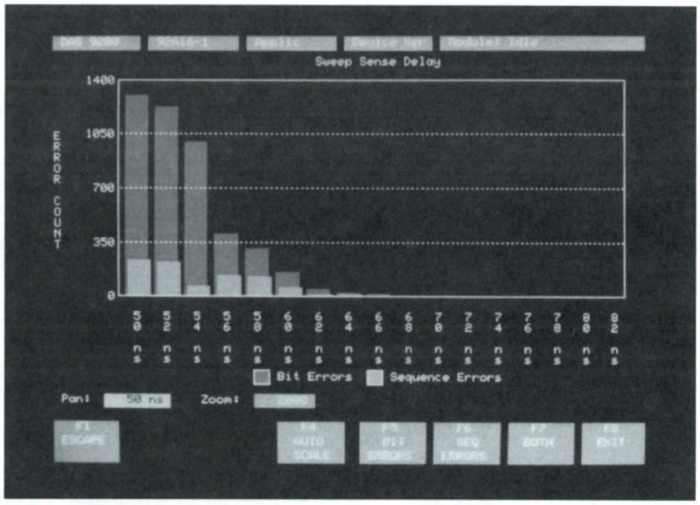
After the ASIC verification process, you can continue to capitalize on your investment by easily reconfiguring the DAS 9200 mainframe for use in circuit-board integration and system-level testing.



DAS 9200 ASIC verification system configuration.



Results are displayed with differences from expected results highlighted in red. In the same display, both stimulus and expected results patterns may be edited for easy "what if" experimentation.



Graphs like this give a clear picture of test results. For example, when timing parameter sweeps are specified, a graph of the number of bit and sequence errors versus the value of the varying parameter can be displayed.

DAS 9200 ASIC VERIFICATION SYSTEMS

DAS 9260—135 Channels (64 NRZ, 7RZ/R1 force/64 sense)

DAS 9262—203 Channels (96 NRZ, 11RZ/R1 force/96 sense)

DAS 9264—271 Channels (128 NRZ, 15RZ/R1 force/128 sense)

Each System Includes:
- Mainframe w/Terminal
- Expansion frame (DAS 9262 & DAS 9264 only)
- 92DV ASIC Verification Software
- 92S32 force modules (as needed to meet channel requirements)
- 92A16 sense modules (as needed to meet channel requirements)
- TF100 Test fixture
- 92C02 GPIB/expansion module (DAS 9262 & DAS 9264 only)

92DV SOFTWARE

Simulator Links
- Tek CAE Systems (standard)
- CADAT
- Daisy
- Hilo
- Lasar
- Mentor
- Valid
- (simple format for links to proprietary simulators)

DAS 9200 Resource Allocation

Data Sampler
(Event to State conversion and compensation for test-instrumentation parameters)

Test Control
- Single Test
- Loop Continuously
- Loop until Pass
- Loop until Fail

- Sweep Period
- Sweep Sense Point
- Sweep RZ/R1 delay
- Sweep RZ/R1 width

Display Results
- Highlighted Errors
- Graph Displays
- Pattern Editing

Operable as a standalone device or under the control of a host (such as a PC), the DAS 9200 can move from engineering to manufacturing with no loss of functionality.

Circuit-Board Functional Test

The variety of acquisition and stimulus modules available on the DAS 9200 make it an ideal tool for circuit-board functional testing. Local mass storage and high-speed 9200-host communications help minimize upload/download time and overall test time. Time-correlated module interactions let you use data acquired by one module to change the activity of another for more realistic conditional testing.

Up to three expansion mainframes (DAS92E9) can be connected to the DAS 9219 for a total of 28 slots. Systems with two or more expansion mainframes must be rackmounted. Mainframes may be reversed in rackmounted versions so probe cables and ports are in front.

Any standard 19-inch rack may be used to rackmount the DAS 9200. Part numbers for Tektronix racks are listed in Logic Analyzers accessories section.

Test Fixtures for Simplified Connections

Circuit board and ASIC test fixtures are available to minimize setup time and simplify connections.

The TF100 ASIC test fixture can also be used to fixture small circuit boards. The TF100 supports 320 pins and uses interchangeable adapter cards.

ORDERING INFORMATION

NOTE: All DAS 9200 products (including standard configurations, mainframes, and modules) include an extended warranty providing one year of on-site service.

STANDARD CONFIGURATIONS

Model Number	Recommended Application	Composed of*1	Performance Overview	Price
DAS 9230	General-purpose H/W analysis with 8-, 16-bit microprocessor support	1 92A16 with P6460 probes 1 92A60 1 92S16	16-ch 200-MHz async/100-MHz sync 8-, 16-bit μP support 18-ch, 50-MHz stimulus	$36,930
DAS 9232*2	General-purpose H/W analysis with 8-, 16-, 32-bit microprocessor support	1 92A16 with P6460 probes 1 92A16E with P6460 probes 1 92A90 1 92S16 1 92S32 with P6465 probes	32-ch 200-MHz async/100-MHz sync 8-, 16-, 32-bit μP support 50-ch 50-MHz stimulus	$60,280
DAS 9240	Timing analysis	1 92A16 1 92A16E	32-ch 200-MHz async/sync	$30,400
DAS 9242	High-speed timing	1 92HS8 1 92A16 1 92A16E	8-ch 2-GHz async 32-ch 200-MHz async/sync	$55,940
DAS 9250	8-, 16-bit microprocessor support	1 92A60	60 ch 20-MHz async/sync supports one 8-, 16-bit μP	$22,420
DAS 9252	8-, 16-, 32-bit microprocessor support	1 92A90	90 ch 20-MHz async/sync supports one 8-, 16-, or 32-bit μP	$26,030
DAS 9254	Dual microprocessor support	2 92A90	180-ch 20-MHz async/sync supports two 8-, 16-, or 32-bit μPs	$41,050
DAS 9260*3	ASIC prototype verification	1 92A16 with P6460 probes 3 92A16E with P6460 probes 2 92S32 with P6465 probes TF100 test fixture 92DV software	128-pin 50-MHz ASIC verification system: 64 pins acquisition and 64 pins stimulus	$70,110
DAS 9262*2	ASIC prototype verification	1 92A16 with P6460 probes 5 92A16E with P6460 probes 3 92S32 with P6465 probes TF100 test fixture 92DV software DAS 92E9 expansion M/F 92C02 expansion/GPIB	192-pin 50-MHz ASIC verification system: 96 pins acquisition and 96 pins stimulus	$109,850
DAS 9264*3	ASIC prototype verification	2 92A16 with P6460 probes 6 92A16E with P6460 probes 4 92S32 with P6465 probes DAS 92E9 expansion M/F 92C02 expansion/GPIB TF100 test fixture 92DV software	256-pin 50-MHz ASIC verification system: 128 pins acquisition and 128 pins stimulus	$137,000
DAS 9270*2	Circuit-board functional test	1 92A16 with P6460 probes 5 92A16E with P6460 probes 3 92S32 DAS 92E9 expansion M/F 92C02 expansion/GPIB	192-pin 50-MHz test system: 96 pins acquisition and 96 pins stimulus	$97,120
DAS 9272*3	Circuit-board functional test	2 92A16 with P6460 probes 6 92A16E with P6460 probes 4 92S32 DAS 92E9 expansion M/F 92C02 expansion/GPIB	256-pin 50-MHz test system: 128 pins acquisition and 128 pins stimulus	$122,890
DAS 9274	Circuit-board functional test	2 92A90 6 92S32 DAS 92E9 expansion M/F 92C02 expansion/GPIB	360-pin 20-MHz test sytem: 180 pins acquisition and 192 pins stimulus	$113,920
DAS 9276*3	Circuit-board functional test	3 92A90 8 92S32 DAS 92E9 expansion M/F 92C02 expansion/GPIB	512-pin 20-MHz test system: 270 pins acquisition and 256 pins stimulus	$150,480

*1 *All configurations include a DAS 9219 mainframe and 920IT color display.*
*2 *Includes mainframe Option 1A (115-V, single-phase power supply, 15-A power cord).*
*3 *Includes mainframe Option A4 (230-V, single-phase power supply, 10-A power cord).*

MAINFRAMES

DAS 9219 Mainframe only **$8,970**
Includes: Mainframe chassis with 8 slots, backplane board, controller board, 2-Mb memory board (resides in slot 1), 20-Mb hard disk drive, 360-Kb floppy disk drive, power supply, 3 RS-232 ports, system software.
DAS 9229 Mainframe and Color Display **$11,420**
Includes: DAS 9219 (see above) and 9201T high-resolution color display.
DAS 92E9 Expansion Mainframe **$6,205**
Includes: Mainframe chassis with 8 slots, backplane board, expansion slave board, power supply. Contains no mass storage or external communications.
9201T High-Resolution Color Display **$3,635**

OPTIONS

Option 04— Mainframe EMI shielding (meets VDE 0871, Class B). Requires 220 V input voltage. **+$1,200**
Option 05— Rackmount hardware. **+$400**
Option 1A— 115 V/15 A power cord.*1 **NC**
Option 1B— 125/208 V 3-phase power supply. **+$180**
Option 10— 1.2-Mb floppy disk drive.*3 **+$250**
Option 2C— GPIB/Expansion board.*2*3 **+$1,950**
Option 3C— Expansion board. **+$1,350**
Option 88— Factory configuration and test. **NC**

*1 *Cannot be ordered with DAS 9260, 9264, 9272, 9276.*
*2 *Cannot be ordered with DAS 9262, 9264, 9270, 9272, 9274, 9276.*
*3 *Cannot be ordered with DAS 92E9.*

Up to three expansion mainframes can be connected, in daisy-chain fashion, to a DAS 9219. To connect an expansion mainframe, slot 8 of the previous mainframe must contain an Expansion/GPIB card or Expansion card. This card connects to the expansion slave board in the DAS 92E9. The maximum 9200 system configuration of one DAS 9219 and three DAS 92E9s yields 28 card slots: 6 in the DAS 9219, 7 in the first and second DAS 92E9s, and 8 in the third DAS 92E9.

INTERNATIONAL POWER PLUG OPTIONS

Standard Configurations/Mainframes/Display
Option A1— Universal Euro 220 V, 50 Hz.
Option A2— UK 240 V, 50 Hz.
Option A3— Australian 240 V, 50 Hz.
Option A4— North American 240 V, 60 Hz.
Option A5— Switzerland 220 V, 50 Hz.

MAINFRAME FIELD-INSTALLABLE OPTIONS

92C02 Expansion/GPIB board (same as mainframe Option 2C) **$1,950**
92C03 Expansion board (same as mainframe Option 3C) **$1,350**
92F02 92HS8 Interface card and cable. Updates 91HS8 to 92HS8 **$2,675**
92F03 92HS8E Interface card and cable. Updates 91HS8 to 92HS8E **$2,675**
92F10 1.2-Mb Floppy Disk Drive (same as mainframe Option 10) **$600**
92F12 20-Mb Hard Disk Drive **$400**
92F1B 3-Phase Power Supply (same as mainframe Option 1B) **$3,350**

INSTRUMENT CARDS

NOTE: The following products include probes. Refer to page 130 for probe descriptions.
92A16 16-Ch, 200 MHz Data Acq **$9,750**
Includes: Two P6461 probes.
92A16E 16-Ch, 200 MHz Acquisition Expander **$9,340**
Includes: Two P6461E probes.
92A60 60-Ch, 20 MHz Data Acquisition Supports 8-, 16-bit microprocessors **$11,860**
Includes: Buffer probe and general purpose leadset.
92A90 90-Ch, 20 MHz Data Acquisition Supports 8-, 16-, 32-bit microprocessors **$15,470**
Includes: Buffer probe and general purpose leadset.
92HS8 8-Ch, 2 GHz Data Acquisition **$25,980**
Includes: 9 permanently attached probes. Requires 2 mainframe slots. Can be expanded to 16-ch with 92HS8C. Can be expanded to 32-ch with 92HS8E and two 92HS8C; 32-ch requires only 2 slots.
92HS8E 8-Ch, 2 GHz Acq. Expander **$25,980**
Includes: 9 permanently attached probes. Requires only 1 mainframe slot. Can operate without 92HS8 but supports only 8 channels. When used with 92HS8, can be expanded to 16 channels with 92HS8C.
92HS8C 8-Ch, 2 GHz Acq. Cabinet **$24,940**
Includes: 9 permanently attached probes. Expands 92HS8/92HS8E from 8 to 16 channels without using additional slots. Cannot operate alone; requires 92HS8/92HS8E.
92S16 18-Ch, 50 MHz Algorithmic Pattern Generator **$7,290**
Includes: Two P6464 probes.
92S32 36-Ch, 50 MHz Sequential Pattern Generator **$10,930**
Includes: Four P6464 probes.

APPLICATION SOFTWARE

Microprocessor Support—See page 128.
92DV ASIC Prototype Verification Software **$5,000**
Includes: Link to CAE Systems simulators.

OPTION

Option 3M—Simulator links to Mentor, Daisy, Hilo, CADAT, LASAR, and Valid in one package **+$2,000**

OTHER PRODUCTS

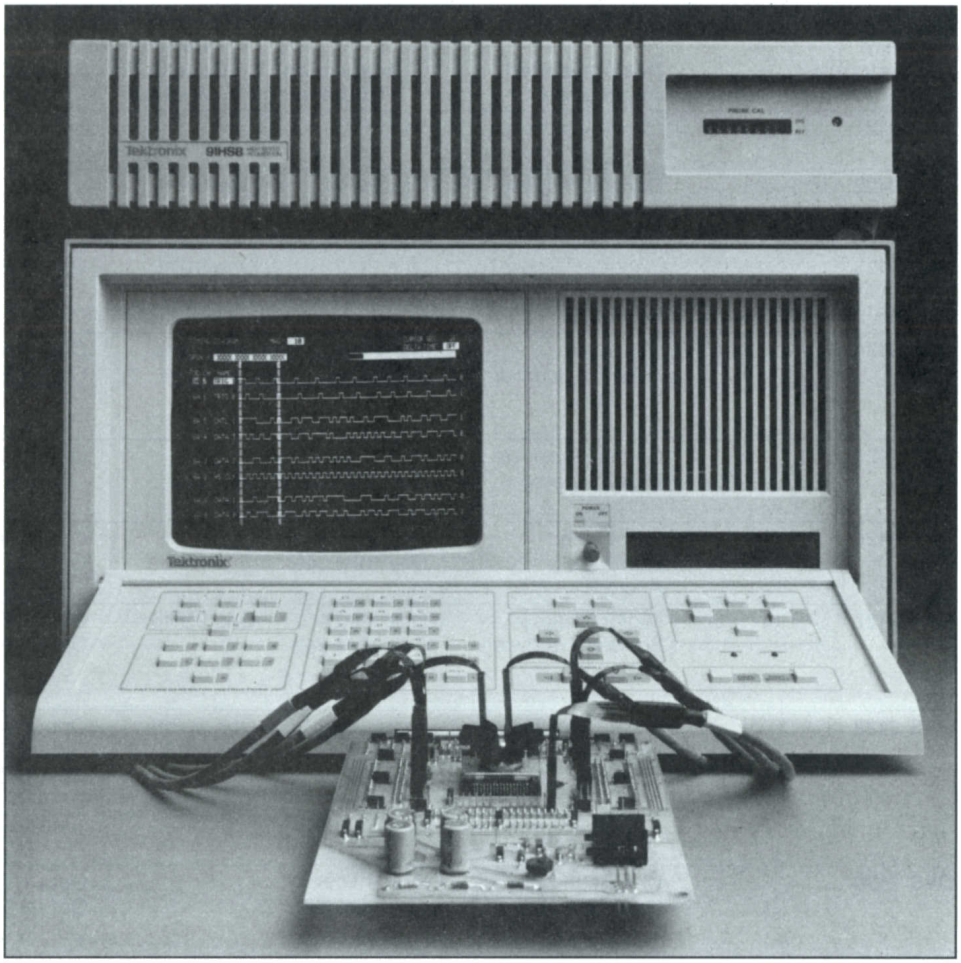
92SIMLK—Simulator links to Mentor, Daisy, Hilo, CADAT, LASAR, and Valid in one package **$2,000**
TF100— ASIC Verification Test Fixture. 320 pins, 50-MHz. **$5,000**
92CART— Mobile AnthroCart for DAS 9200 **$355**
Instrumentation Rack—Single-bay, standard 19-in. rack with cooling fans and choice of power controllers.
With 115 V/30 A power controller. Order 437-0241-00 **$3,815**
With 220 V/15 A power controller. Order 437-0244-00 **$4,240**
Blank Panels For Instrumentation Rack
1¾ inch. Order 333-1351-00 **$16**
3½ inch. Order 333-0997-00 **$27**
5¼ inch. Order 333-0999-00 **$12.25**
7 inch. Order 333-1352-00 **$13**
8¾ inch. Order 333-0998-00 **$14.25**
10½ inch. Order 333-0996-00 **$14.75**
9200 Rackmount Kit (same as mainframe Option 05)—Order 016-0845-00 **$450**

DAS 9100 Series

Digital Analysis System

GPIB IEEE-488 The DAS 9100 Series Option 06 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Color Display Enhances Ease-of-Use and Increases Productivity**
- **Acquisition Speeds to 2-GHz (500 ps)**
- **Data Widths to 104 Channels**
- **State-Table and Timing Diagrams Displayed for All Channels**
- **Pattern Generation Up to 192 Channels at 50-MHz**
- **VAXBI Bus Simulation and Debug**
- **91DVS Software Links DAS 9100 to IBM PC for Bench-Top VLSI Functional Testing**
- **TF100 Test Fixture Supports Devices to 320 Pins at 50-MHz**
- **Disassembly Support for 24 Microprocessors and Buses**
- **Memory Depths From 512 to 8032 Bits per Channel**
- **Disassembly Support for Proprietary Processors and Buses**
- **Triggering to 16 Levels**
- **Patented Time Correlation of High-Speed and Low-Speed Data**
- **Separate Glitch Memory**
- **Supports GPIB, RS-232, Hard-Copy Units and Serial Line Printers**
- **Tape Drive Stores Patterns and Instrument Setups for Future Use**
- **Thirteen Standard Application Configurations Available or Custom Design Your Own System**



The Industry Standard

The DAS 9100 Series Digital Analysis System has set the industry standard for virtually all aspects of logic analysis. Its modular mainframe accepts a wide assortment of both data-acquisition and pattern-generation modules to fit your application needs.

High Speed

The 91HS8 acquisition module provides up to 32 channels at a 2-GHz asynchronous sample rate (500 picocosecond sample interval). The 91HS8 combines the time resolution of an oscilloscope with the flexible triggering, glitch detection, memory depth, and channel width of a logic analyzer.

Ease of Use

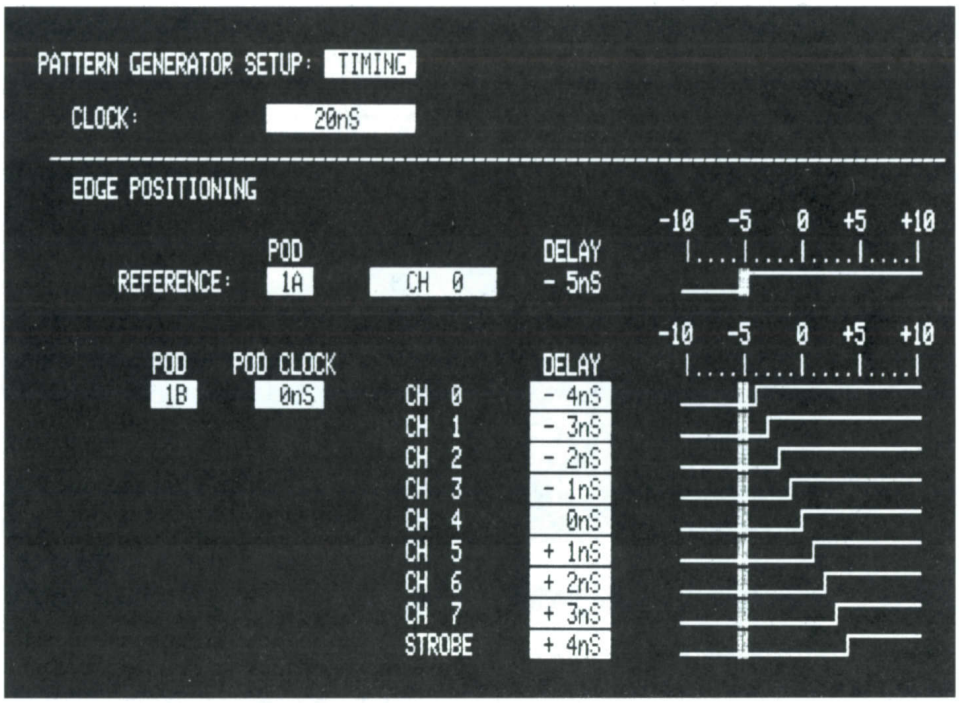
Besides color, the DAS 9100 Series includes many other important human engineering features. Its menu-driven user interface is easy to learn and self-documenting. There is a color-coded keyboard organized specifically to enhance user programming. All keys are arranged into logical groups that correspond to the display elements.

DAS 9100 PERFORMANCE SUMMARY

Module Name	Type	Channels	Maximum Channels	Memory Depth	Speed	Application
91HS8/91HSE8	Acquisition	8	32	8000	2 GHz	Ultra High-Speed Hardware Analysis
91A04A/91AE04A	Acquisition	2/4	16	4096/2048	660/330 MHz	High-Speed Hardware Analysis
91A08	Acquisition	8	32	512	100 MHz	Hardware Analysis
91A32	Acquisition	32	96	512	25 MHz	Hardware/Software Analysis
91A24/91AE24	Acquisition	24	96	1024	10 MHz	Sophisticated Software Analysis
91S16	Pattern Generator (Algorithmic)	16	176 with five 91S32	1024	50 MHz	High-Speed HW/SW Simulation
91S32	Pattern Generator (Stored-Pattern)	32	192	2048	50 MHz	High-Speed HW/SW Simulation
91P16/91P32	Pattern Generator (Algorithmic)	16/32	80	254	25 MHz	Hardware/Software Simulation

DAS 9100 STANDARD CONFIGURATIONS

Standard Configuration Model Number	Recommended Application	Acquisition Modules	Pattern Generation Modules	Options Included	Performance Features
DAS 9121	General-Purpose Hardware Analysis	Two 91A08			16-Channel, 100-MHz Data Acquisition
DAS 9122	General-Purpose Acquisition With Stimulus	One 91A32	One 91P16		32-Channel, 25-MHz Data Acquisition 16-Channel, 25-MHz Pattern Generation
DAS 9123	General-Purpose Software/Hardware Integration	One 91A32 One 91A08	One 91P16	Opt 03 Power	32-Channel, 25-MHz Data Acquisition 8-Channel, 100-MHz Data Acquisition 16-Channel, 25-MHz Pattern Generation
DAS 9124	Expanded Software/Hardware Integration	Two 91A32 Two 91A08	One 91P16	Opt 01 Tape Opt 04 Power	64-Channel, 25-MHz Data Acquisition 16-Channel, 100-MHz Data Acquisition 16-Channel, 25-MHz Pattern Generation DC-100 Tape Mass Storage
DAS 9125	General-Purpose Microprocessor Support	One 91A24 One 91AE24		Opt 01 Tape	48-Channel, 10-MHz Data Acquisition DC-100 Tape Mass Storage
DAS 9126	High-Speed Hardware Analysis	One 91A04A One 91AE04A		Opt 01 Tape Opt 03 Power	4-Channel, 660-MHz or 8-Channel, 330-MHz Data Acquisition DC-100 Tape Mass Storage
DAS 9127	Microprocessor Software/Hardware Integration	One 91A24 One 91AE24 One 91A08	One 91P16	Opt 01 Tape Opt 03 Power	48-channel, 10-MHz Data Acquisition 8-Channel, 100-MHz Data Acquisition 16-Channel, 25-MHz Pattern Generation DC-100 Tape Mass Storage
DAS 9128	Interactive ATE: VLSI Verification	Three 91A32	One 91P16 Two 91P32	Opt 01 Tape Opt 04 Power Opt 06 Comm	96-Channel, 25-MHz Data Acquisition 80-Channel, 25-MHz Pattern Generation DC-100 Tape Mass Storage GPIB/RS-232 Communications Interface Serial Line Printer Port Display Video Output
DAS 9130	Ultra High-Speed Hardware Analysis	One 91HS8 Three 91HSE8		Opt 01 Tape Opt 03 Power Opt 06 Comm	32-Channel, 2-GHz Data Acquisition DC-100 Tape Mass Storage GPIB/RS-232 Communications Interface Serial Line Printer Port Display Video Out
DAS 9131	General-Purpose Acquisition With Stimulus	One 91A32 One 91A04A	One 91S32	Opt 01 Tape Opt 04 Power Opt 06 Comm	32-Channel, 25-MHz Data Acquisition 4-Channel, 330-MHz Data Acquisition 32-Channel, 50-MHz Pattern Generation
DAS 9132	General-Purpose Acquisition With Stimulus	One 91A32 One 91A08	One 91S16 One 91S32	Opt 01 Tape Opt 04 Power Opt 06 Comm	32-Channel, 25-MHz Data Acquisition 8-Channel, 100-MHz Data Acquisition 48-Channel, 50-MHz Pattern Generation
DAS 91VB	VAXBI Bus Simulation and Debug	One 91A24 Three 91AE24	One 91P16 One 91P32	Opt 01 Tape Opt 04 Power Opt 06 Comm	96-Channel, 10-MHz Data Acquisition 48-Channel, 25-MHz Pattern Generation VB100 VAXBI Support Package
DAS 9118 with DAS 9119 ATE Mainframe	Remote-Only Operation; Display and Keyboard not Included	Three 91A32	One 91P16 Two 91P32	Opt 04 Power Opt 06 Comm	96-Channel, 25-MHz Data Acquisition 80-Channel, 25-MHz Pattern Generation CRT and Keyboard Deleted GPIB/RS-232 Communications Interface Serial Line Printer Port Display Video Output



The 91S16/91S32 50-MHz pattern generator modules let you adjust the timing relationships between output clocks and data channels in 1 ns increments.

Pattern Generation

The DAS 9100 is the first logic analyzer with both acquisition and pattern generation in the same instrument. Pattern generation makes it possible to start debugging hardware before the software, or all of the hardware, is available. You can also use pattern generation to test VLSI devices. VLSI test software (91DVS) and a 320-pin VLSI test fixture are available.

Microprocessor Support

Tektronix offers the widest selection of microprocessor support packages in the industry. See Microprocessor and Bus Support at the end of this section.

VAXBI Bus Simulation and Debug

The DAS 91VB, a configured DAS 9100 system, supports the 32-bit VAXBI bus from Digital Equipment Corporation. Developed in cooperation with DEC, the DAS 91VB is a complete VAXBI test system that can fully monitor and simulate the VAXBI bus. The DAS 91VB can be used as a standalone or from a VAX-connected terminal. Special control software installed on the VAX automatically performs all VAX-DAS 91VB communications and translations.

ORDERING INFORMATION

STANDARD CONFIGURATIONS

DAS 9121	$16,370	**DAS 9128**	$45,760
DAS 9122	$17,380	**DAS 9130**	$108,000
DAS 9123	$22,165	**DAS 9131**	$32,840
DAS 9124	$33,390	**DAS 9132**	$48,250
DAS 9125	$19,540	**DAS 91VB**	$51,930
DAS 9126	$24,550	**DAS 9118**	$40,710
DAS 9127	$28,315		

MAINFRAME ONLY

DAS 9129 Color Mainframe $8,400
Includes: P6452 probe; P6454 external clock probe; ejector tool (214 3154-00); operators manual (062-5847-09); workbook (062-7596-00).
DAS 9119 ATE Mainframe (Deletes CRT and Keyboard; Adds Option 06) $6,350
Includes: Same as above.

MAINFRAME OPTIONS

Option 01—DC-100 Tape Drive. +$1,450
Option 03—One Additional Power Supply. +$800
Option 04—Two Additional Power Supplies. +$1,600
Option 05—Rackmount Hardware. +$200
Option 06—GPIB, RS-232, Line Printer Port. +$1,550
Option 88—Mainframe shipped with modules installed and checked as part of the mainframe. NC

INTERNATIONAL POWER PLUG OPTIONS

Option A1— Universal Euro 220 V, 50 Hz.
Option A2— UK 240 V, 50 Hz.
Option A3— Australian 240 V, 50 Hz.
Option A4— North American 240 V, 60 Hz.
Option A5— Switzerland 220 V, 50 Hz.

MAINFRAME FIELD-INSTALLABLE OPTIONS

DAS 91F1— Field-Installed Option 01 (Includes Installation in Service Center). $1,700
DAS 91F3— Field-Installed Additional Power Supply. $800
DAS 91F6— Field Installed Option 06 (For Mainframes Above S/N B020100). $1,700

MAINFRAME MODULES

The following modules include probes. See Probe Selection Guide on page 130 for more information. Maximum of six modules per mainframe, 104 data-acquisition channels, 80 pattern-generator channels when using 91P16/91P32, or 192 pattern-generator channels when using 91S16/91S32.

91AE04A—Data Acquisition, Expander $5,950
91AE24—Data Acquisition, Expander $4,700
91A04A—Data Acquisition, 660/330 MHz $7,950
91A08—Data Acquisition, 100 MHz $3,985
91A24—Data Acquisition, 10 MHz $4,990
91A32—Data Acquisition, 25 MHz $4,990
91HS8—Data Acquisition, 2 GHz $25,000
91HSE8—Data Acquisition, Expander $25,000
91P16—Pattern Generator, 25 MHz $3,990
91P32—Pattern Generator, 25 MHz $6,900
91S16—Pattern Generator, 50 MHz $6,900
91S32—Pattern Generator, 50 MHz $10,400

Note: When adding modules, check that the correct number of power supplies is also selected. The mainframe includes sufficient power for two modules. One additional power supply (Option 03) is required for three or four modules. Two additional power supplies (Option 04) are required for a total of five or six modules.

PROBES

P6452—8-Channel Data Acquisition Probe. $730
P6453—4-Channel Data Acquisition Probe. $1,560
P6454—External Clock Probe For 91A08 Modules. (Only one required, included with each DAS 9100 Mainframe.) $265
P6455—8-Channel TTL/MOS Pattern Generator Probe. $575
P6456—8-Channel ECL Pattern Generator Probe. $575
P6457—4-Channel Tri-State Pattern Generator Probe. $575
P6460—8-Channel Data Acquisition Probe. $700
P6462—8-Channel TTL Only Data Acquisition Probe. $340
P6463—TTL/CMOS Pattern Generator Probe. 9-Channels at 50 MHz or 16-Channels at 25 MHz. For use with 91S32. $1,000
P6464—8-Channel TTL/ECL Pattern Generator Probe. $1,350

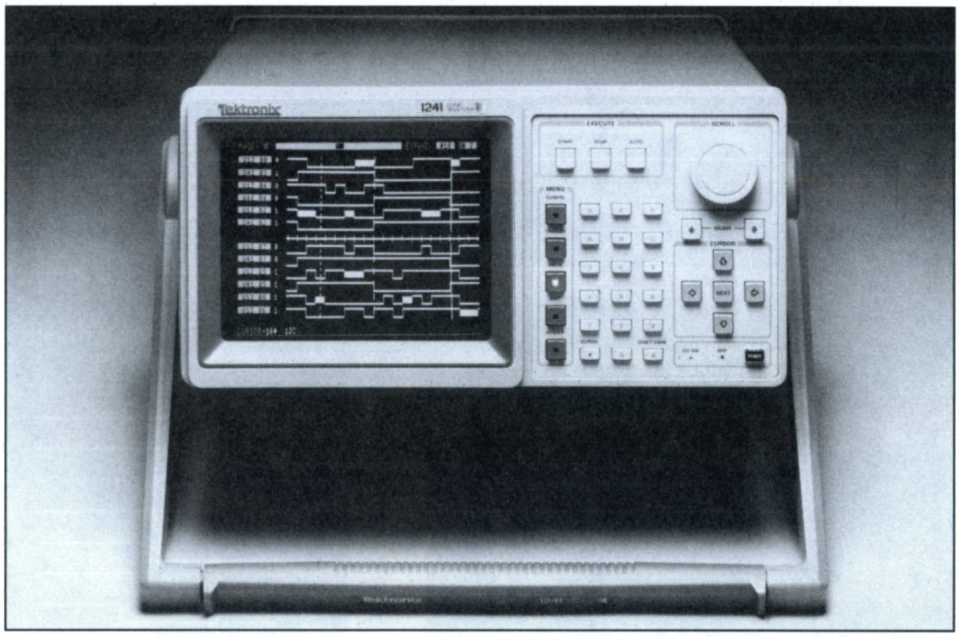
OTHER PRODUCTS

91DVS IBM PC XT/AT-DAS 9100 Device Verification Support Package $5,000
TF100 VLSI Device Test Fixture, 320 pins, 50 MHz $5,000
VB100 VAXBI Bus Support Package $8,950

1240/1241

GPIB IEEE-488 The 1240/1241 comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Total Design Support: Hardware, Software, and Integration**
- **1241's Color Display Enhances User Interface**
- **Up to 72 Acquisition Channels**
- **Acquisition Speeds to 100 MHz Async, 50 MHz Sync**
- **14 Levels of Triggering With Conditional Branching**
- **Dual Time Base Triggering, Acquisition, and Display**
- **Simple Menu Operation With On-Screen Soft Keys**
- **Transfers Easily Into Manufacturing and Service**



Expanded 1241 Timing Diagram With Glitches.

TOTAL PERFORMANCE

With the 1240/1241 Logic Analyzers, the key phrase is **total performance.** These instruments provide complete support for all aspects of the design task, including hardware analysis, software analysis, and integration.

The 1241 color mainframe with its LCCS (Liquid-Crystal Color Shutter) and 1240 monochrome mainframe provide rapid setup and operation. Use of either instrument is made simple through a straightforward menu-oriented approach, combined with multilevel operation and touch-screen soft keys. Multi level operation allows the user to select from one of four levels best matched to the user's skill level and the task at hand. Touch-screen soft keys provide high-level commands at a keystroke, keeping operator selections simple and well labeled.

Hardware Analysis

For hardware analysis, the 1240/1241 offer up to 36 channels of acquisition at sampling rates of 100 MHz asynchronous and 50 MHz synchronous. 6 ns glitch detection is also available.

Standard memory depth of 512 bits per channel can be extended to a maximum of 2048 bits per channel by using a special memory chaining feature. This feature allows you to chain one card's memory to another, trading channel width for memory depth.

Superior hardware triggering capabilities include data and glitch triggering for isolating the problem area; clocked and unclocked triggering for capturing events that might not coincide with sample points; and counters, timers, and duration filters for triggering on the characteristics of a signal as well as its occurrence.

Auto-run capability allows you to track intermittents through continuous acquisitions and change parameters on the system under test and dynamically monitor their effects.

Software Analysis

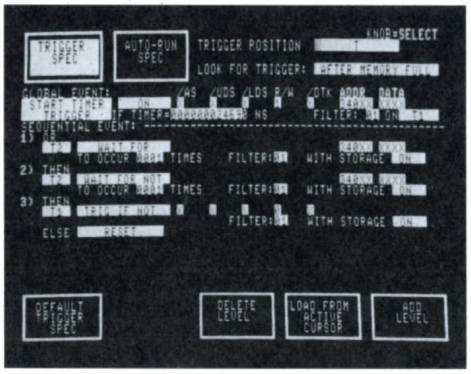
Software analysis is supported by up to 72 data chanels at sampling rates of 50 MHz synchronous/asynchronous. A flexible clocking scheme includes data demultiplexing without double-probing

Powerful software triggering capabilities are provided so you can track program flow. Included are 14 trigger levels, conditional branching, counters, timers, and both program flow and data flow qualification. These functions are implemented in two independent event recognizers.

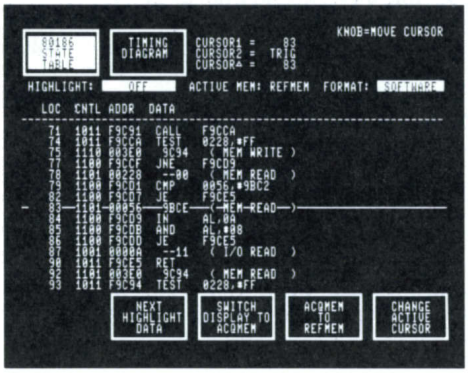
Other features that assist in software analysis are flexible channel groupings for display, standard display radices (including ASCII and EBCDIC), and an eight-level pattern search and memory compare with highlighting.

Hardware/Software Integration

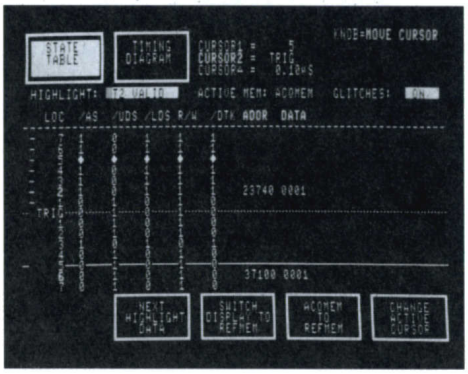
The 1240/1241 offer a dual time base system that integrates all the hardware and software analysis capabilities. The dual time base system greatly speeds the hardware/software integration process by typing together the acquisition, triggering, and display of two independent time bases. You can fully monitor the interaction between hardware and software, or



Trigger Specification Menu.



80186 Software Format.



State Table Display with Dual Time Base Acquisition.

the relationship of two interdependent systems. All data displays are timealigned and completely correlated. The dual time base allows you to integrate functional modules, an increasingly important design task.

FLEXIBILITY NOW AND IN THE FUTURE

The power of the 1240/1241 stems from the configurable architecture of the mainframes. You can select features that meet your current application needs, then later upgrade the mainframe to increased performance.

Selectable Acquisition Cards

Each mainframe has four card slots which accommodate any combination of 9-channel (1240D1) and 18-channel (1240D2) data acquisition cards, with a maximum of 72 channels.

ROM Packs for Data Processing

Data processing capabilities can be added by inserting ROM packs into the ROM port on the side of the mainframe. These ROM packs provide the capability to capture data which is very specific to your problem at hand and assist in analyzing that data, by processing it and presenting it to you in the most useful manner. Currently, there are ROM Packs supporting performance analysis (12R01) and mnemonic disassembly (12RMXX) of popular microprocessors, busses and digital signal processors. Special communications applications, such as printer support (12RC01) and master/slave (12RC02), require both a ROM Pack and COMM Pack.

COMM Packs for External Communications

Communication capabilities can be added by inserting COMM Packs into a communications port on the rear of the mainframe. These COMM Packs act as adapters, allowing the 1240/1241 to function in different communication environments. The 1200C01 supports RS-232C, the 1200C02 supports GPIB, and the 1200C11 supports the parallel printer interface.

EASE OF USE

In line with Tek's goal of easy-to-use logic analyzers, the 1240/1241 human interface has been designed to facilitate the user's operation of the instrument.

Menu Operation and Soft Keys

Ease of use starts with the 1240/1241's menu operating system. Straightforward menu displays and on-screen soft keys allow you to make set-up choices on the screen where your attention is already directed. You are not distracted by the need to look elsewhere on the instrument.

Multiple Operation Levels

Another major feature of the menu operating system is user-selected operation levels. The 1240/1241 provide four operation levels, ranging from basic operation for simple applications to full operation for complex applications. The sophistication of system features increases with the operation levels.

Configurable From the Front Panel

The 1240/1241 are completely configurable from the front panel, thus eliminating the need to switch boards and reconnect probes when changing from hardware to software applications. Probe connections are on the side of the instrument so they can be easily accessed. The keyboard has a simple layout, with single-function keys. Also, a knob is included on the keyboard for data scrolling. This knob, along with the extreme smoothness of the data scrolling, makes the 1240/1241 displays easier to read and manipulate.

Automatic Nonvolatile Storage

A battery-backed CMOS memory stores two complete instrument set-ups, including the last set-up used before the 1240 or 1241 is powered down. This facilitates quick instrument start-up when returning to work, and eliminates the problem of losing a set-up as a result of power system interruptions.

IDEALLY SUITED FOR ENGINEERING, MANUFACTURING, AND SERVICE

In addition to their usefulness in the engineering environment, the 1240/1241 are well suited for manufacturing and service tasks. They transfer easily from one environment to another and help facilitate communications between the different groups through their portability, remote control, mass storage, and teleservicing capabilities.

Portability

The 1241 weighs 12.7 kg (28.0 lb) and meets environmental Class 5 specifications. The 1240 weighs 12.0 kg (26.5 lb) and meets environmental Class 3 specifications.

Remote Control

The 1200C01 RS-232C and 1200C02 GPIB COMM Packs are ideally suited to automated test environments and remote control.

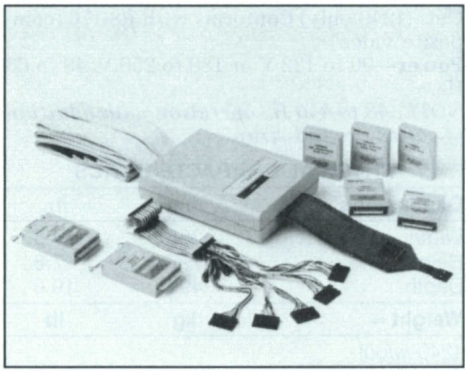
Mass Storage

Mass storage of set-ups, acquisition memories, and reference memories is achieved through RAM and EPROM Packs.

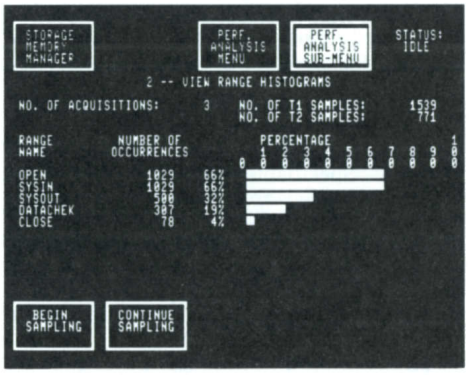
Storage and retrieval of information from the 12RS01 8K RAM Pack and the 12RS02 64K RAM Pack is accomplished via menu soft keys. The 12RS11 32K EPROM Pack (no EPROMs included) and the 12RS12 32K EPROM Pack (EPROMs included) provide a permanent storage medium for set-ups and memories. Menu soft keys are used to retrieve files.

Teleservicing

Master/Slave capability allows one 1240/1241 to remotely control another over a telephone line. This capability greatly eases the higher levels of service troubleshooting, as service specialists can get to the problem via the telephone rather than having to physically travel to the problem site. The 1240/1241 supports master/slave operation with the following configuration at each end of the phone line: 12RC02 Master/Slave ROM Pack, a 1200C01 RS-232C COMM Pack and a modem.



Personality Module with COMM Packs and ROM Packs.



View Range Histograms Menu.

Scroll Knob.

CHARACTERISTICS

Characteristics are common to the 1240/1241 unless otherwise indicated.

OPERATING LEVELS

Level 0—Basic operation.
Level 1—Advanced timing analysis (includes basic state analysis).
Level 2—Advanced state analysis (includes basic timing analysis).
Level 3—Full operation.

TIME BASES

Two per Instrument—Assignable by probe. Time Base 1: Asynchronous or Synchronous. Time Base 2: Synchronous or Demultiplex.

INPUTS

Clocks—C1, C2, . . . Cn. Where n= number of probes = number of channels/9. Minimum Pulse Width: 8 ns. Specifiable as rising, falling, or either edge.
Qualifiers—Q1, Q2, . . . Qn. Where n= number of probes = number of channels/9. Set-up Time, Hold Time: = (P6460) 11 ns, 0 ns; (P6462) 17 ns, 6 ns. Specifiable as high or low level.
Asynchronous—Rate: 1240D1: 10 ns to 1 s, (1240D2: 20 ns to 1 s). Specification: (1-2-5 sequence)•(Q1•Q2• . . .•Qn). Accuracy: 0.01%. Channel-to-Channel Skew: ±3 ns. Glitch Detection: (1240D1 only) 6 ns.
Synchronous—Rate: Dc to 50 MHz. Set-up Time, Hold Time: On 1240D1 is (P6460) 7 ns, 2 ns; (P6462) 12 ns, 7 ns. On 1240D2 is (P6460) 12 ns, 0 ns; (P6462) 17 ns, 5 ns. Specification: (C1 + C2 + . . . +Cn)•(Q1•Q2•. . .•Qn). Minimum Delay After Previous Clock: 20 ns.
Demultiplex—Rate: Dc to 50 MHz. Set-up Time, Hold Time: On 1240D1 is (P6460) 7 ns, 2 ns; (P6462) 12 ns, 7 ns. On 1240D2 is (P6460) 12 ns, 0 ns; (P6462) 17 ns, 5 ns. Specification: First Phase Clock (Latch Data) (C1 + C2 + . . . + Cn)•(Q1•Q2•. . .•Qn). Minimum Delay After Last Phase Clock: 20 ns. Last Phase Clock (Store Data): (C1 + C2 + . . . + Cn)•(Q1•Q2•. . .•Qn). Minimum Delay After First Phase Clock: 10 ns.

DATA ACQUISITION CARDS

Two types of acquisition cards: 1240D1, 1240D2. Maximum of four cards per 1240/1241, in any combination.

	1240D1	1240D2*2
Number of Channels	9	18
Max Asynchronous Rate	100 MHz	50 MHz
w/Glitches	50 MHz*1	N/A
Max Synchronous Rate	50 MHz	50 MHz
Memory Depth		
(Bits/Channel	512	512
w/Glitches)	256	N/A
Max Depth via Chaining	2048	2048

*1 *Glitch capture available on all channels.*
*2 *Supports single probe demultiplexing.*

Depth vs Channels—Tradeoffs possible between data acquisition cards of same type. Maximum depth is 2048 (with four 1240D1 or four 1240D2).

DATA ACQUISITION PROBES

Two Types of Acquistion Probes: P6460, P6462. One probe required per 1240D1, two per 1240D2.

	P6460	P6462
Signal Input		
Data Channels	9	9
Clock/Clock		
Qualifier Lines	1	1
Nominal Impedance	1 MΩ, 5 pF	≈1 LTTL
Threshold Range	−6.35 to +6.35 V	+1.4 V
Increments	0.05 V	—
Accuracy	±0.5% ±0.065 V	±0.25 +0.0055 V/ (0−25°C)
Threshold Assignment	By acquisition card	—
Polarity Assignment	By channel	By channel
Max Input Voltage		
Peak	±40 V	−2 to +7 V
Channel to Channel	± 60 V	No restriction

NOTE: All system specifications are based upon P6460 probes, for specifications based upon P6462 probes, please refer to the 1240/1241 Data Sheet.

TRIGGER DEFINITION (TWO EVENT RECOGNIZERS)

Global Event Recognizer (Event Recognizer #1)—One level. Event Recognition specified by: Word recognizer—data (data or glitch on 1240D1). Duration filter—1 to 16 consecutive samples or 10 ns to 160 ns. Commands: Store On (Not), Trigger On (Not), Reset On (Not), Start Timer On (Not), Time While On (Not), Increment Counter On (Not), or Off. Counter/timer: Clock interval is 10 ns. Range is 0 to 99,999,999,999 (either counts or 10 ns increments) Counter/timer value may be used to cause trigger or reset.
Sequential Event Recognizer (Event Recognizer #2)—14 levels. Event Recognition on Each Level Specified By: Time Base: Which time base to monitor for event. Word Recognizer: Data (data or glitch on 1240D1). Iteration Counter: 1 to 9999 occurrences. Duration Filter: 1 to 16 consecutive samples. Selective Storage on Each Level Specifiable: With Storage On or With Storage Off. Commands on Each Level: Wait For (Not), Trigger If (Not), Reset If (Not), Jump If (Not) or Delay (up to 9999). Commands at End of Sequence: Trigger, Reset or Do Nothing.
External Trigger Out—TTL level output whenever trigger attempted.
External Trigger In—TTL level input can be required for enabling trigger.

AUTORUN
Four Modes of Operation

Compare Acquisition Memory to Reference Memory—Specifiable which channels to compare, specifiable starting and ending memory locations of comparison. Specifiable result of Comparison Outcome: Display and reacquire, discard and reacquire, or display and stop. Specifiable Minimum Display Time: 0 s to 99 s.
Continuous Trigger Out—Data is not stored. 1240/1241 acts as trigger source.
Trigger In—Requires Trigger In signal to enable trigger. Enables two 1240/1241s to work in parallel.
Store After Trigger—Data at last trigger is available after stopping 1240/1241. Time between storages is minimum.

DISPLAY FORMATS

State Table—Acquisition or reference memory. Data displayed in binary, octal, hex, ASCII, EBCDIC. Glitch display can be turned on or off.
Timing Diagram—Acquisition or Reference Memory. Horizontal Expansion: *1, *2, *5, *10, *20. Vertical Expansion: (1241 only): *1, *2.
Distance Between Cursors—Value displayed as absolute time for unqualified asynchronous measurement, as number of memory locations for qualified or synchronous measurement.
Highlighting Modes—Memory comparison differences, glitches, search pattern occurrences, time base 1 occurrences, time base 2 occurrences.
Search Pattern—Length: 1 to 8 contiguous locations.

STORAGE

Internal (Standard)
Nonvolatile Memory (NVM)—Size: Contains two set-ups, including status at power down, lithium iodide battery.
Volatile Memory (RAM)—Size: Contains two set-ups.
Memory Types
Set-Up—Stored in NVM, RAM, or Pack, contains all data pertinent to making an acquisition.
Reference Memory—Stored in Pack, reference memory is editable in Edit Reference Memory menu.

ENVIRONMENTAL

Temperature—Operating: 1240 is -10 to +55° C; 1241 is 0 to 50° C. Nonoperating: -62 to +85° C.
Altitude—Operating: To 4600 m (15,000 ft). Nonoperating: To 15,000 m (50,000 ft).
Vibration—0.025-inch displacement. 10-to 55-Hz frequency range.
Shock—30 g.

OTHER CHARACTERISTICS

Diagnostics—At power-up, the 1240/1241 performs processor, ROM, RAM and board checks. A test pattern generator located on the side provides stimulus for verifying probes and acquisition system operation. Complete system verification and extended diagnostics are available with an optional ROM Pack.
Rear Panel Connections— Trigger In: TTL compatible. Trigger Out: TTL compatible. Video Out: (1240 only) Conforms with RS-170 (composite video).
Power—90 to 132 V or 180 to 250 V, 48 to 63 Hz.
NOTE: 48 to 440 Hz operation with addition of safety ground strap.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	368	14.5
Height	197	7.8
Depth	498	19.6
Weight ≈	**kg**	**lb**
1240 w/out Accessories	12.0	26.5
1241 w/out Accessories	12.7	28.0

ROM Packs

Analysis

12R01 (Performance Analysis)—State Overview: 1 to 11 ranges. Ranges can be different groups and different time bases. Ability to halt and resume measurement. Display in count, percentage, and histogram. Event Measurement: 1 to 11 distribution intervals. 1 to 4 events. 10 ns resolution. Five measurement types (measure total time, count cycles, count occurrences, time occurrence, accumulate time). Display in distribution, min, mean, max, and histogram.

Communication Support

12RC01 (Printer Support)—Requires: 1200C01 for serial interface or 1200C11 for parallel interface. Output: Menus, search pattern, acquisition and reference memory. Memory Format: State table, timing diagram, and combined.

12RC02 (Master/Slave)—Requires: 1200C01 and modem. With Option 01: Auto-answer, auto-dial, voice-data switching, nonvolatile storage of four phone numbers, 300 baud and 1200 baud. Diagnostics: Local 1240/1241 with COMM Pack and RS-232 cable, modem, and link between local and remote 1240/1241.

External Storage (Optional)

12RS01 (8K RAM Pack)—Size: Contains 8K bytes with Lithium Iodide battery.

12RS02 (64K RAM Pack)—Size: Contains 64K bytes with Lithium Iodide battery.

12RS11 (32K EPROM Pack)—Size: Contains 32K bytes (no EPROMs included). Requires four 68764s or 68766s.

12RS12 (32K EPROM Pack)—Size: Contains 32K bytes. Comes with four 68764s or 68766s.

Microprocessor Support

12RMXX (Mnemonic Disassembly)—Formats: State, Absolute, Hardware, Software. Provides printer support for all four display formats when 1200C01 (for serial printer interface) or 1200C11 (for parallel printer interface) is installed.

COMM Packs

1200C01 (RS-232C)—Baud Rate: 110 to 9600. Bits/Character: Eight, including parity bit. Protocol: Asynchronous full duplex. Stand alone with host for remote control, with 12RC01 for printers with serial interface, with 12RC02 and 12RC02 Option 01 for master/slave, with 12RMXX for printers with serial interface.

1200C02 (GPIB)—Full listener/talker capabilities. Meets IEEE Standard 488-1978. Compatibility: Stand alone with host for remote control.

1200C11 (Parallel Printer)—Compatibility: With 12RC01 for printers with parallel interface, with 12RMXX for printers with parallel interface.

ORDERING INFORMATION

1240 Logic Analyzer Mainframe **$4,500**
Includes: Accessory pouch (016-0707-00); front panel cover (200-2780-00); operator manual (070-4340-01); reference guides (070-4641-01).

1241 Color Logic Analyzer Mainframe **$6,000**
Includes: Same as above.

Option 05—Rackmount Adaptor. **+$400**

STANDARD SYSTEM CONFIGURATIONS

8-BIT

1240N08—8-Bit Microprocessor Analysis System **$11,160**
Includes: 1240 Logic Analyzer with two 1240D2 modules with four P6460 probes, 12RS02 RAM Pack.

1241N08—8-Bit Microprocessor Analysis System **$13,900**
Includes: Same as above except the 1241 Logic Analyzer.

OPTIONS

Options 01 thru 09—Microprocessor Specific Support (Includes: 12RMXX Microprocessor Disassembly ROM Pack, 12RMXX Option 01 Configured Probe Interface).

Option 01—Support for 8080. **+$600**
Option 02—Support for 8085. **+$600**
Option 03—Support for 6800. **+$600**
Option 04—Support for 6802. **+$600**
Option 05—Support for 6808. **+$600**
Option 06—Support for 6809. **+$600**
Option 07—Support for Z80. **+$600**
Option 08—Support for 6502. **+$600**
Option 09—Support for NSC800. **+$600**

16-BIT

1240N16—16-Bit Microprocessor Analysis System **$12,600**
Includes: 1240 Logic Analyzer with three 1240D2 Option 1D modules without probes, P6460 probe, 12RS02 RAM Pack

1241N16—16-Bit Microprocessor Analysis System **$14,100**
Includes: Same as above except the 1241 Logic Analyzer.

OPTIONS

Options 01 thru 09—Microprocessor Specific Support (Includes: 12RMXX Microprocessor Disassembly ROM Pack, 12RMXX Option 02 or Option 04 Personality Module).

Option 01—Support for 8086. **+$2,500**
Option 02—Support for 8088 **+$2,500**
Option 03—Support for 80186. **+$2,500**
Option 04—Support for 80188. **+$2,500**
Option 05—Support for 68000 (DIP). **+$2,500**
Option 06—Support for 68000 (PGA). **+$2,500**
Option 07—Support for 68008. **+$2,500**
Option 08—Support for 68010 (DIP). **+$2,500**
Option 09—Support for 68010 (PGA). **+$2,500**

GENERAL PURPOSE

1240NGP General-Purpose Analysis System **$15,350**
Includes: 1240 Logic Analyzer with 1240D1 module with P6460 probe; two 1240D2 modules with four P6460 probes; 12RS02 RAM Pack.

1241NGP General-Purpose Analysis System **$16,850**
Includes: Same as above except the 1241 Logic Analyzer.

BUS ANALYSIS

1240NBA Bus Analysis System **$19,800**
Includes: 1240 Logic Analyzer with four 1240D2 modules with eight P6460 probes, 12RS02 RAM Pack.

1241NBA Bus Analysis System **$21,300**
Includes: Same as above except the 1241 Logic Analyzer.

HIGH-SPEED ANALYSIS

1240NHS High-Speed Analysis System **$16,800**
Includes: 1240 Logic Analyzer with four 1240D1 modules with four P6460 probes, 12RS02 RAM Pack.

1241NHS High-Speed Analysis System **$18,300**
Includes: Same as above except the 1241 Logic Analyzer.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

ACQUISITION CARDS

1240D1—9-Channel Data Acquisition Card, 100 MHz, includes one P6460 Data Acquisition Probe. **$2,950**
Option 1D—Deletes one P6460 Data Acquisition Probe. **−$700**

1240D2—18-Channel Data Acquisition Card, 50 MHz, includes two P6460 Data Acquisition Probes. **$3,700**
Option 1D—Deletes two P6460 Data Acquisition Probes. **−$1,400**
Option 2S—Substitutes two P6462 Data Acquisition Probes for two P6460 Data Acquisition Probes. **−$720**

DATA ACQUISITION PROBES

P6460—9-Channel Data Acquisition Probe. **$700**

P6462—9-Channel Data Acquisition Probe, fixed threshold TTL. **$340**

COMMUNICATION INTERFACES (COMM PACKS)

1200C01—RS-232C COMM Pack. **$750**
1200C02—GPIB COMM Pack. **$850**
1200C11—Parallel Printer COMM Pack. **$500**

Note: To order cables for these COMM Packs, see the Logic Analyzer Accessories Section.

ROM PACKS

Analysis
12R01—Performance Analysis ROM Pack. **$800**

Communication Functions
12RC01—Printer Support ROM Pack. **$300**
12RC02—Master/Slave ROM Pack. **$500**
Option 01—Modem. **+$600**

Microprocessor Mnemonic Disassembly
12RMXX—See Microprocessor Support for ordering information.

Storage
12RS01—8K RAM Pack. **$300**
12RS02—64K RAM Pack. **$500**
12RS11—32K EPROM Pack (Empty). **$85**
12RS12—32K EPROM Pack. **$300**

SERVICE ACCESSORIES

12RD01—Diagnostic ROM Pack. **$1,500**
Diagnostic Lead Set—Order 012-0556-00 **$65**
Extender Card—Order 670-7539-02 **$465**
Service Manual—Order 062-7124-02 **$150**
Service Maintenance Kit—Includes the above service accessories. Order 067-1103-03*[1]

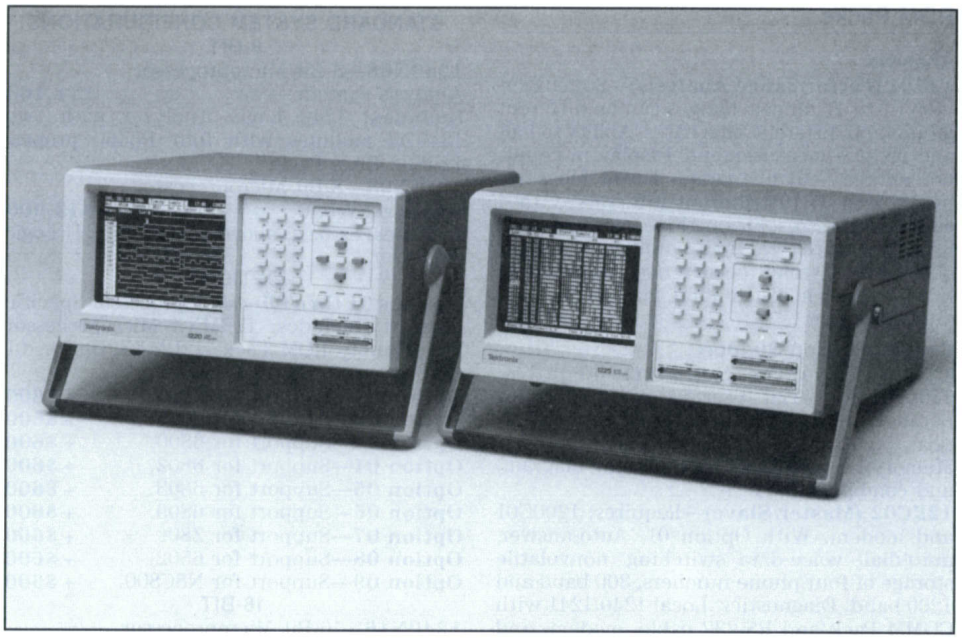
CART

K212—Portable Instrument Cart. See Cart section. **$350**

[1] To order, contact your local Tektronix Sales Office.

1220/1225 Logic Analyzers

- **Affordable**
- **Supports μP Disassembly**
- **Timing up to 100 MHz**
- **Large Display**
- **Easy to Learn Pop-Up Menus**
- **Every Channel Displayed in State or Timing Format**
- **Multiple Time Bases**
- **Glitch Capture**
- **4 Nonvolatile 2K Memories Per Channel**
- **Nonvolatile Storage for 8 Setups**
- **Nonvolatile Calendar Clock**
- **Portable—Less Than 20 Pounds**
- **RS-232 Interface (Optional)**
- **Printer Port (Optional)**



1220 and 1225 Logic Analyzers

The 1220 and 1225 Logic Analyzers have been designed specifically to provide true general purpose logic analysis, including microprocessor analysis, at an affordable price. The feature sets have been selected to allow the user to perform the measurements and tests needed, while keeping the human interface straightforward and easy to use.

The 1225 has 48 data channels as well as twelve external clock inputs and six external qualifier inputs. These inputs enable the 1225 to do general-purpose state and/or timing measurements, plus disassemble 8-bit and 16-bit microprocessors.

The 1220, with 32 data channels, can disassemble 8-bit microprocessors. Eight external clock inputs and four external qualifier inputs are available.

Within each 16-channel group, the user can trade off channel count versus speed. For some problems 16 channels at 25 MHz may fit the need better. Since the user can make these decisions independently by group, he can, for instance, configure the 1225 to handle an 8-bit microprocessor (state/disassembly) and simultaneously acquire 4 signals at 100 MHz for timing analysis.

DATA DISPLAY

The large, clear display of the 1220/1225 helps the user find the data of interest quickly and easily. In state tables the data may be displayed in several different radices. The easy-to-read timing diagrams assist the user in locating timing errors with a minimum of effort. The ability to set the size of the steps for scrolling allows the operator to scroll the data display at whatever rate is optimal for the task at hand.

When ever a Personality Module is installed, the disassembly displays are available. Hardware disassembly displays each hardware bus cycle, providing information on the electrical interactions of the circuit under test. Software disassembly condenses the display to provide a compact summary of the instruction sequence actually processed by the microprocessor.

1220/1225 PERFORMANCE SUMMARY

	1220	1225
Number of Sync Channels	32	48
Async Channels		
@ 25 MHz	32	48
@ 50 MHz	16	24
@ 100 MHz	8	12
@ 25 MHz (or less) with glitches	16	24
Memory depth per channel	2048	2048
Nonvolatile 2K Memories	4	4

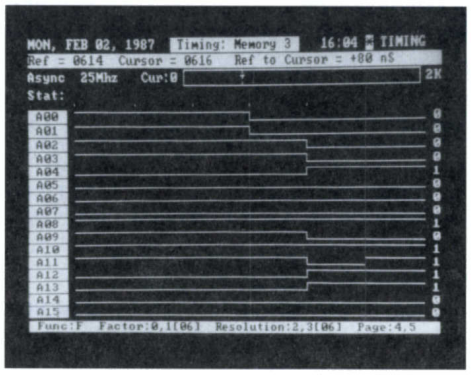
MEMORY SELECT

Each channel of the 1220/25 is backed with 2048 bits of acquisition memory. In addition, there are four separate nonvolatile 2K memories, any of which can be used for the current acquisition. The other memories are useful for reference memory storage. Any two of the memories can be compared; the differences are memory storage. Any two of the memories can be compared; the differences are highlighted in the State Table display.

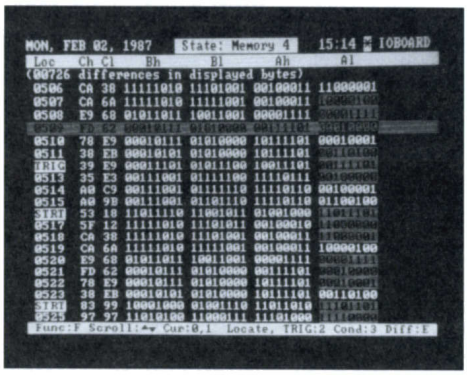
In addition to the four nonvolatile 2K memories, the 1220/25 provides nonvolatile storage for saving eight instrument setups.

CONFIGURABLE

Data channels are divided into 16-channel groups, one group per P6442 probe. Within each 16-channel group, you can trade off channel count versus speed. Each group supports 16 channels at 25 MHz, 8 channels at 50 MHz, or 4 channels at 100 MHz. You make the channel-count/speed decision independently by channel group. For example, you can configure the 1225 to handle an 8-bit microprocessor (state/disassembly) and simultaneously acquire 4 signal at 100 MHz for timing analysis.



Timing Diagram. Use the reference cursor to measure pulse widths or the time between edges.



1225 State Table display with differences between reference memory highlighted.

TIMEBASE

The multiple time base architecture allows the user to select a different clock source for each 16-channel group. For instance, all three channel groups on a 1225 can be clocked synchronously (at two different rates if desired). Or some groups can be clocked synchronously while others are clocked asynchronously. Such configurations are useful for system debug, allowing the user to gather data from different parts of the system. Up to two different internal asynchronous clock rates may be used simultaneously.

Clocking is assigned by channel group (2 groups in 1220, 3 groups in 1225). Each channel group may be clocked synchronously or asynchronously, independent of other channel groups.

External Time Base Inputs

	1220	1225
Clocks		
active high	4	6
active low	4	6
Qualifiers		
active high	2	3
active low	2	3

TRIGGER SPECIFICATION

The function of the trigger circuit on a logic analyzer is to help the user find the data of interest quickly and easily. The 1220 does 1225 this with a simple sequence of statements which identify data to be stored and data of greatest interest.

Up to 24 conditions may be named and specified, where each bit is defined as 0,1 or X(DON'T CARE).

The sequence of conditions defined in the Trig Spec menu controls the acquisition of data in the analyzer. Up to 12 lines of trigger spec statements may be selected.

TTL-compatible External Trigger In and Trigger Out connections are provided for communicating with other test equipment, such as an oscilloscope.

HARDCOPY CAPABILITY

A video out connector (RS-170 composite, 60 frames/sec) is standard equipment. A parallel printer port is optional. This port lets you produce printouts on low-cost printers that use the Epson graphics character set.

REMOTE CONTROL

An optional RS-232 interface provides programmable remote control of the 1220/1225 for automated test environments. A host, such as a PC, can use the RS-232 interface to upload or download any of the 8 stored setups or any of the 4 sample memories in the 1220/1225. The host can also emulate the 1220/1225 keyboard.

OTHER CHARACTERISTICS

The 1220/1225 provides on-screen, context-sensitive Notes messages. The Notes contain information about menus and selections, as well as explanations of terminology. Also, the 1220/1225 provides nonvolatile clock/calendar, plus a "screen saver" feature that automatically shuts down the CRT when not in use to avoid screen burn.

Display—7 inch CRT with auto screen power down and variable intensity (both selectable under program control).

Clock/Calendar—Date and Time set by menu control, nonvolatile, 3 V lithium battery.

Rear Panel Connections—Trigger In: TTL Compatible. Trigger Out: TTL Compatible. Video Out: RS-170 (composite), 60 frames/sec. RS-232C Interface and Printer Port optional.

POWER

Line Voltage Ranges—90 to 132 V AC, 47 to 63 Hz, 180 to 264 V AC, 47 to 63 Hz.

ENVIRONMENTAL

Temperature—Operating: 0 to 50°C. Nonoperating: 40 to 65°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	360	14.0
Height	180	7.0
Depth	420	16.5
Weight ≈	kg	lb
Net (1220)	8.4	18.5
(1225)	8.8	19.5

Data Acquisition Probe—P6442 General Purpose Probe, Signal Input: 16 Data Channels, 2 Active High Clocks, 2 Active Low Clocks, 1 Active High Qualifier, 1 Active Low Qualifier, 3 Active High External Trigger Inputs, 3 Active Low External Trigger Inputs. Impedance: Data Channels ≥1M, 15 pF, Others ≥100K, ≥10 pF, TTL Input Threshold: Fixed. Maximum Input Voltage: Static is −2.5 to 8.0 V.

ORDERING INFORMATION

1220 32-Channel Logic Analyzer **$3,995**
Includes: Two P6442 probes; demo/test circuit; 6 flying lead sets; 48 grabber tips; power cord; operator manual.

1225 48-Channel Logic Analyzer **$5,395**
Includes: 3 P6442 probes; demo/test circuit; 9 flying lead sets; 72 grabber tips; power cord; operator manual.

OPTIONS

Option 01—RS-232 Interface Port **+$495**
Option 02—Parallel Printer Port **+$250**

PROBES

P6442—16 Channel State/Timing Probe **$500**

FIELD-INSTALLED OPTIONS

12F01—Field-installed RS-232 Interface Port **$595**
12F02—Field-installed Parallel Printer Port **$350**

PERSONALITY MODULES

PM402—Z-80 Microprocessor **$600**
PM403—6502 Microprocessor **$600**
PM404—8085 Microprocessor **$600**
PM405—STD BUS **$600**
PM406—6809 Microprocessor **$600**
PM407—6800 Personality Module*1
PM411—8086/88 Personality Module*1
PM412—68000 Personality Module*1

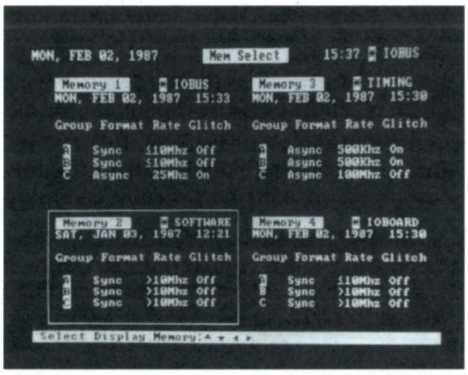
INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

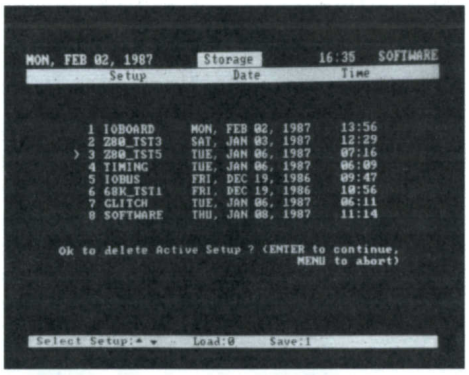
*1 *Contact your local sales office for information.*

OPTIONAL ACCESSORIES

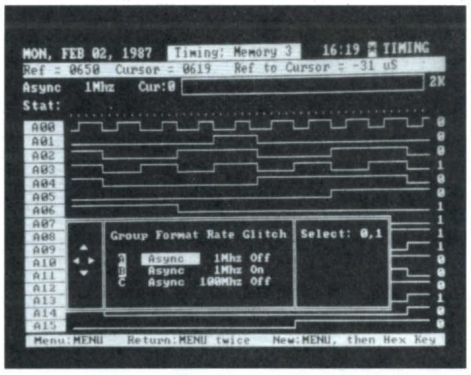
Grabber Tips—Package of 12, Order 020-1386-00. **$41**
Lead Sets—
(Black) Order 174-0752-00. **$30**
(Red) Order 174-0763-00 **$30**
(White) Order 174-0764-00 **$30**
Accessory Pouch—Order 016-0707-00 **$65**



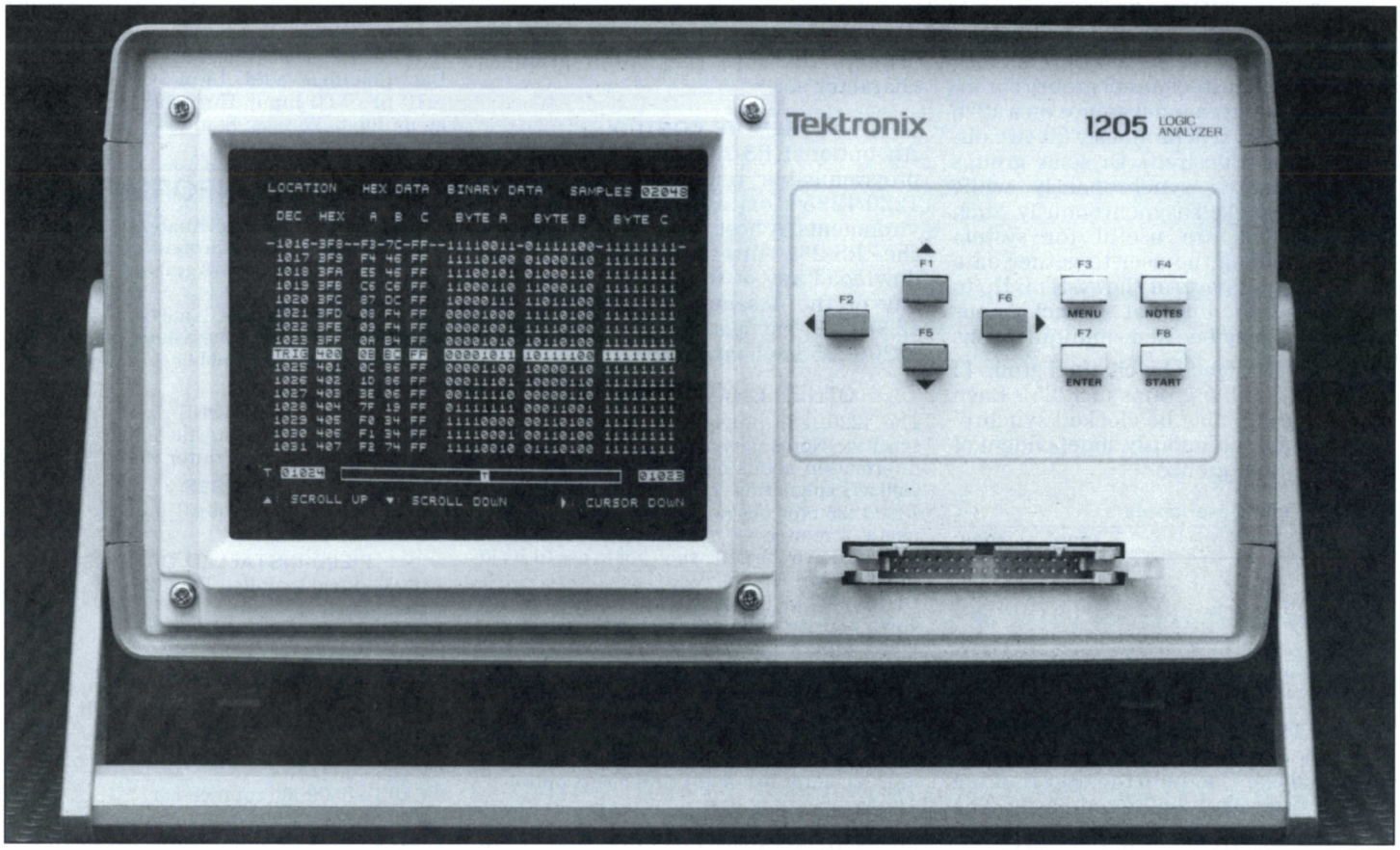
Memory Select. Four separate, nonvolatile 2K memories.



Nonvolatile Storage for 8 instrument setups.



1225 Timebase pop-up menu display over timing diagram.



1205 Logic Analyzer

1205 Logic Analyzer

- **Affordable**
- **Supports μP Disassembly**
- **Easy-to-read Display**
- **Easy to Learn and Use**
- **Ideal for Education Applications**
- **Timing up to 100 MHz**
- **Captures Glitches**
- **Video Output Port**

The 1205 Logic Analyzer provides low cost basic logic analysis functions. The 1205 supports state, timing, and some microprocessor analysis and is the ideal choice for the first-time user of logic analyzers. The versatility of the 1205 also makes it ideal for training environments where students can be exposed to various aspects of digital test.

The 1205 has a single probe connector which accepts specific probes for different applications. Connecting the probe automatically displays the proper menus for that type of application.

State Analysis

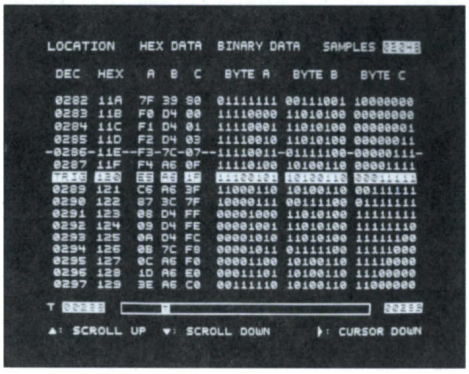
For state analysis, the P6440 24-channel state probe provides the connections for 24 data channels and three external clocks (or qualifiers).

Timing Analysis

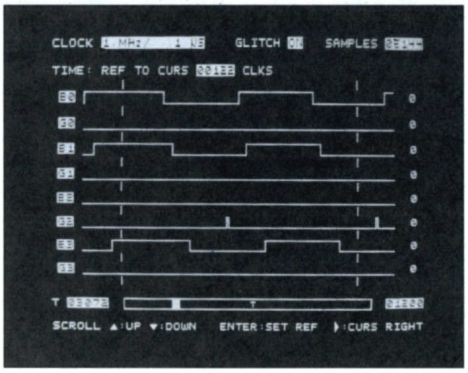
The large, clear display of the 1205 helps the user find the data of interest quickly and easily. In state tables the data is displayed in both hex and binary formats for easy recognition. For timing analysis, the P6441 probe, samples data at up to 25 MHz. Under program control the user can trade channels for speed by selecting four channels at 50 MHz or two channels at 100 MHz. Glitches can be captured on four channels.

Microprocessor Analysis

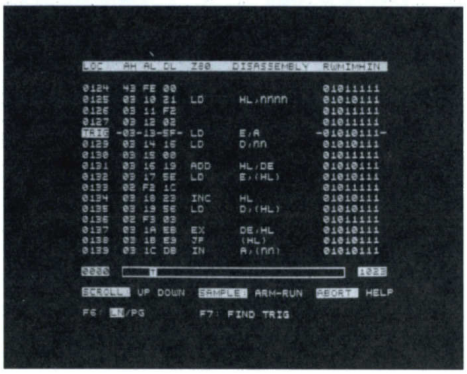
For microprocessor analysis, the 1205 accepts dedicated personality modules for two of the most popular μP's: the Z80 and the 6502. There is also a user-configurable microprocessor interface probe which acquires 40 channels of data with advanced triggering capability.



1205 State Display



Timing Display Showing Glitches on Trace G2



1205 Z80 Disassembly Display

CHARACTERISTICS

CLOCK

Asynchronous—Repetition Rate. Internal: 25 Hz to 100 MHz in a 2.5, 5, 10 sequence. External: Up to 25 MHz. Minimum pulse width (External Clock) is 15 ns.
Synchronous—Three Clock Inputs: CLK1, CLK2 and CLK3. Each input can be selected positive-going or negative-going. For each group of eight channels, the clock is the logical OR or NOR of CLK1, CLK2 and CLK3. All three channel groups may be sampled with the same clock or with separate clock signals. Clock Repetition Rate: Up to 9 MHz, minimum clock pulse width is 15 ns.

TRIGGER

Condition Specifications—The trigger condition for each of the 24 data channels may be specified as 1, 0 or X (Don't Care). All three 8-channel groups may be considered as a single 24-bit trigger condition, as two separate conditions of 16 bits and 8 bits, or as three separate conditions of 8 bits each. The second case is useful for specifying situations such as ADDRESS bus = XXXX followed by DATA bus = XX. Sequence Selection: The user selects one of the sequences from the Trigger menu by use of the cursor and ENTER keys. Trigger Delay: 0 to 2047 samples.

STATE TABLE DISPLAY

Memory Depth Per Channel—2048

P6440 State Probe
Signal Input—24 Data Channels. 3 Clocks/Qualifers. External Trigger.
Impedance—All inputs ≥1M, ≤5 pf. CMOS/TTL Input Threshold (fixed).
Maximum Input Voltage—Static:-2.5 to 8.0 V. Pulse (10% duty): -5.5 to 12 V.
Data Setup Time—20 ns.
Data Hold Time—0 ns.

TIMING ANALYSIS

The 1205 Logic Analyzer uses the P6441 Timing Probe to provide logic timing analysis for a variety of applications.

In timing analysis the clock is usually provided by the logic analyzer. This allows the 1205 to sample data sufficiently, often to locate edges and pulses in the circuit under test accurately.

The 1205 samples data for timing analysis on up to 8 channels at 25 MHz. However, if a greater sampling rate is needed, the user can trade channels for speed by selecting 4 channels at 50 MHz or 2 channels at 100 MHz.

TRIGGER

Condition Specification—Three 8-bit trigger conditions, each bit specified as 1, 0 or X (Don't Care) 1 External Trigger Input.
Sequence Selection—The user selects one of the sequences from the Trigger menu by use of the cursor and ENTER keys. Trigger delay: 0 to full memory length (6143 to 25575 samples).

TIMING DIAGRAM DISPLAY

Memory Depth Per Channel—6144 in most cases, 12288 at 50 MHz, 24576 at 100 MHz.
Glitch Capture—Selectable for sampling rates of 25 MHz or less, 4 channels.
P6441 Timing Probe
Signal Input—8 Data Channels. 1 External Clock. 1 External Trigger.
Impedance—≥1M, ≤5 pf. TTL/CMOS Input Threshold (fixed).
Maximum Input Voltage—Static:-2.5 to 8.0 V. Pulse (10% duty): -5.5 to 12 V. Minimum guaranteed glitch detection: 10 ns.

MICROPROCESSOR ANALYSIS

Whenever a Personality Module is installed, the disassembly display is available.
Clock—When the Personality Module for the specific microprocessor is installed, the proper clocking is automatically selected and connected. No user interaction is required.
Conditions—The CONDITIONS menu allows the user to specify up to 8 condition terms which are used in the trigger sequence. Each condition consists of up to 40 bits, each of which may be stated as 0, 1 or X (Don't Care).
Trigger—In the TRIGGER menu the user specifies the exact sequence of conditions (up to 16 program steps) which define the circumstances under which the 1205 should trigger.

Trigger Program Statements:
SEARCH [condition][number times]
FIND [condition][number times]
WAIT [number cycles]
START
STOP
SAMPLE [number times]
REPEAT [number times]

Disassembly Display—The disassembly display shows the data acquired by the 1205 and also the disassembled instruction codes for the microprocessor. Thus the user can easily see the assembly language instructions (for software analysis) and also the actual bit states (for hardware analysis). The data may be displayed in either binary or hex format.
Memory Depth Per Channel—1024 locations.
Hardware specifications are given for each Personality Module.

PM302 Z80 PERSONALITY MODULE

Provides single-plug connection to Z80, proper configuration of clocks, and disassembly of acquired data.
Channels—32
Input Impedance—Data bus ≥1M, ≤5 pf. Others ≥100 K, ≤10 pf.
Threshold—TTL/CMOS

PM303 6502 PERSONALITY MODULE

Provides single-plug connection to 6502, proper configuration of clocks, and disassembly of acquired data.
Channels—30
Input Impedance—Data bus ≥1M, ≤5 pf. Others ≥100 K, ≤10 pf.
Threshold—TTL/CMOS

PM301 PERSONALITY MODULE

Provides general purpose μP state analysis. Does not support disassembly.
Channels—40
Clocks—Three Strobe Pairs (each pair may be OR'd), Ext Function
Input Impedance—Data Channels ≥5 pf. Others ≥100 K, ≤10 pf.
Threshold—TTL/CMOS
Sense—True or Inverse, on Ext Function and strobe inputs.
Strobe Rate—4 MHz at 40 bits.
Strobe Width—40 ns.
Input Data Setup—20 ns.
Hold—0 ns.

OTHER CHARACTERISTICS

The overall feature set of the 1205 provides the user all the needed features for basic tasks. The microprocessor personality modules are optional. The menus for the instrument automatically reflect the proper features whenever a particular probe is attached.
Display—5 inch CRT, 24 lines of 48 characters.
Rear Panel Connections—Video Out: RS-170 (composite), 60 frames/sec.

POWER

Line Voltage Ranges—90 to 132 V ac, 47 to 63 Hz, 180 to 264 V ac, 47 to 63 Hz.

ENVIRONMENTAL

Temperature—Operating: 0 to 40°C. Nonoperating: -40 to 65°C
Altitude—Operating: To 3000 m (10,000 feet). Nonoperating: To 10 000 m (40,000 feet)

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	250	10.0
Height	130	5.3
Depth	250	10.0
Weight ≈	**kg**	**lb**
Net	3.4	7.5

ORDERING INFORMATION

1205 Logic Analyzer **$2,495**
Includes: P6440 State Probe (24 channels); P6441 Timing Probe (8 channels); Demo Test Circuit; black flying lead set (174-0752-00); red flying lead set (174-0763-00); white flying lead set (174-0764-00); 24 grabber tips (013-0217-00; power cord; operator manual.

OPTION

Option 1D—Deletes standard P6440 and P6441 probes. **-$800**

PROBES

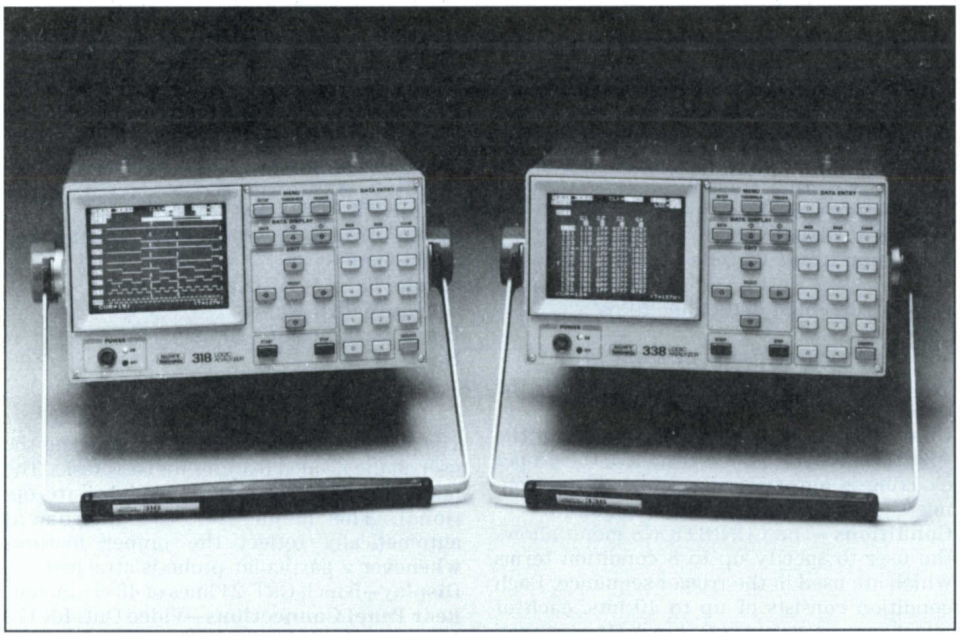
P6440—24-channel State Probe **$400**
P6441—8-channel Timing Probe **$450**

PERSONALITY MODULES

PM301—40-channel General Purpose Microprocessor **$700**
PM302—Z80 Microprocessor **$700**
PM303—6502 Microprocessor **$700**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz
Option A2—UK 240 V, 50 Hz
Option A3—Australian 240 V, 60 Hz
Option A4—North American 240 V, 50 Hz
Option A5—Switzerland 220 V, 50 Hz



NEW 318A/338

Logic Analyzers

- **Parallel and Serial Data Acquisition**
- **State and Timing Displays**
- **32 Channels up to 20 MHz**
  16 Channels up to 50 MHz
  Serial Acquisition up to 19,200 bits/sec
- **Multilevel Triggering**
- **Easy-to-Use Menu-Driven Interface**
- **RS-232 Remote Control Interface**
- **Internal Nonvolatile Memory for Set-Ups and Reference Data**
- **Ultra-Portable and Rugged**

Weighing only 7 kg (15 lb) each, including accessories, these instruments incorporate proprietary LSI circuitry to provide an array of features usually associated with much larger logic analyzers. Both the 318A and 338 include parallel and serial data acquisition capabilities and powerful multilevel triggering. Each instrument can also be controlled remotely via an RS-232 interface, an extremely useful feature in first-line service applications. Also, nonvolatile memory allows both set-up information and reference data to be retained and transported from site to site.

The 318A and 338 Logic Analyzers are built around the same basic feature set. The 338, targeted more toward software applications, allows 32 channels of data acquisition at speeds up to 20 MHz. The 318A includes 16 channels of acquisition at up to 50 MHz, and is a better fit for timing applications. The basic 318A and 338 include parallel data acquisition, state and timing displays, refer ence memory, glitch acquisition and glitch triggering capabilities. The S1 configurations add serial acquisition and an RS-232 remote control interface. For the 338, the S1 configuration also adds nonvolatile memory for storing set-up information and reference data. Nonvolatile memory is standard with the 318A.

Parallel Data Acquisition

The 318A and 338 contain powerful 3-level triggering, allowing the user to specify and capture complex event sequences. The trigger allows definition of three separate events. Up to 65,000 occurrences can be required for the first event. The next two events can be defined to follow immediately or at any time later. The third event can be used to RESET the trigger sequence. In addition, the events can be OR'd together.

Once acquired, parallel information can be displayed as a state table in the radix selected (hex, binary, octal, or decimal) or as a timing diagram. The data can be searched for occurrences of a specified event, or the acquired data can be compared to the data in the reference memory, with differences highlighted on the screen.

In the timing diagram up to eight channels of data can be displayed. Each channel can be assigned a label chosen by the user. For increased ease of use, the delta measurement feature displays the difference between locations of two cursors.

All data channels can be clocked either asynchronously (internal analyzer clock) or synchronously (from the clock of the unit under test). Thus, no reprobing is necessary if the user wishes to select a different clocking mode.

Glitches are recognized and stored. They can also be used as trigger conditions.

Serial Data Acquisition

The S1 configurations include serial data acquisition. Data can be acquired synchronously or asynchronously at up to 19,200 bits per second, with 5 to 9 bits per character. Two-level triggering is available both synchronously and asynchronously. In addition, in synchronous mode, SYNC and HUNT words can be specified.

Serial data can be displayed in state-table or character format. State-table radices include binary, octal, hex, ASCII, and EBCDIC. The character format can be decoded as ASCII or EBCDIC. Data can be searched for specific events, or the acquired data may be compared with data stored in reference memory.

RS-232 Interface for Remote Control

The S1 configurations also include an RS-232 interface which allows complete control of the instrument from a remote processor or terminal. The connection may be made locally or via modems and telephone lines. The remote interface parameters are programmable and can be set easily from the menu interface.

Nonvolatile Memory

Nonvolatile memory is part of the 338S1 configuration and standard to the 318A. This internal nonvolatile memory can store instrument set-ups and reference data. Such storage is useful for rapid and accurate restoration of set ups and reference data under a variety of conditions. It is especially useful at remote service sites where a less skilled technician can configure the instrument quickly and easily, and compare acquired data to expected (reference) data.

CHARACTERISTICS

PARALLEL ANALYZER FUNCTION

DATA INPUT

Channels—318A: 16 channels; glitch data is detected on all 16 channels. 338: 32 channels; glitch data is detected on 8 channels (POD A).
Minimum Logic Swing—500 mV p-p; centered on threshold voltage.
Maximum Logic Swing—Threshold voltage plus 10 V to threshold voltage minus 15 V.
Glitch Data Width—5 ns minimum with 350 mV overdrive from threshold.
Threshold Voltage—TTL: +1.4 V. V 1: −10 to +10 V. V 2: −10 to +10 V. V 3: = (V 1+V 2)/2.

SAMPLING

External Clock Mode	318A	338
Data set-up time	13 ns max	14 ns max
Data hold time	0 ns max	0 ns max
Clock period	20 ns min	50 ns min

300 SERIES COMPARISON SELECTION GUIDE

Characteristics	318A	318AS1	338	338S1
Number of Parallel Data Channels	16	16	32	32
Maximum Asynchronous Sample Rate (MHz)	50	50	20	20
Maximum Synchronous Sample Rate (MHz)	50	50	20	20
Number of Trigger Levels	3	3	3	3
Acquisition Memory Depth (Bits/Channel)	4096	4096	256	256
Reference Memory Depth (Bits/Channel)	4096	4096	256	256
Glitch Capture (Channels)	16	16	8	8
Glitch Trigger (Channels)	16	16	8	8
Serial Data Acquisition	No	Yes	No	Yes
RS-232 Remote Control Interface	No	Yes	No	Yes
Nonvolatile Memory	Yes	Yes	No	Yes
Video Output	Yes	Yes	Yes	Yes

Clock Pulse Width—High-Logic level: 15 ns min. Low-Logic Level: 15 ns.
Clock Polarity—±edge.

INTERNAL CLOCK MODE

Sample Interval—318A: 20 ns to 500 ms/sample in 1-2-5 sequence. 338: 50 ns to 500 ms/sample in 1-2-5 sequence.

Data Memory Depth	318A	338
Acquisition Memory	16×4096 bits	32×256 bits
Reference Memory	16×4096 bits	32×256 bits
Glitch Memory	16×4096 bits	8×256 bits

TRIGGERING

Internal Trigger
Word Recognizer—Three words: A, B, and C; selected channels are AND'd together.
Input—All data input channels from P6451 data acquisition probes.
Glitch Trigger—Selected channels are OR'ed together.
Trigger Position—Begin, Center, End, Delay up to 65,000 clock cycles.
External Trigger
Input—Mini-jack connector on side panel, TTL compatible.
Threshold—1.4 V nominal (TTL level).
Polarity—±edge.
Pulse Width—20 ns minimum.
Trigger Output—Initiated high when an internal trigger sequence, glitch trigger or external trigger is detected. Reset on next acquisition start.
Output Level—TTL.
Current Max—High-Logic Level: 1 mA. Low-Logic Level: 2 mA.

DATA DISPLAY

Timing Diagram Mode—Maximum of eight channels (one page) present on screen at one time. The 318A has two pages; the 338 has four pages. Glitch Display: Displays glitches on timing diagram as a bit width transition edge. Search: Searches for glitches or user defined word.
ΔT—Movable cursor for calculating the number of clocks and temporal distance between two events.
State-Table Mode—Hex, decimal, octal, or binary radix format. Search: Searches for glitches or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

SERIAL STATE ANALYZER FUNCTION DATA INPUT

Data Timing—Synchronous or asynchronous.
Bits/Character—5, 6, 7, 8 or 9 bits (includes parity bit if parity is active).

SAMPLING

Internal Clock for Asynchronous Mode—50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 bits/second.
External Clock for Both Synchronous and Asynchronous Modes—Up to 19,200 bits/second.
Parity Control—Odd, even, or none.

TRIGGER SOURCE

Internal or external.

DATA DISPLAY

State-Table Mode—Hex, binary, octal, ASCII, EBCDIC radix. Search: Searches for parity errors or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.
Character-Table Mode—All bits of memory displayed in either ASCII or EBCDIC radix. Search: Searches for parity errors or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

RS-232 INTERFACE

Data Transmission Type—Asynchronous only.
Communication Mode—Full Duplex.
Bits/Character—Eight bits with parity. Parity—Even.
Data Transfer Rate—110, 150, 300, 600, 1200, 2400, 4800, 9600 bps.
Signal Characteristics—Meets RS-232C standard.
I/O Connector—25 pin standard connector.

NONVOLATILE MEMORY

Memory Size—Three set-ups (serial or parallel) and one memory acquisition or reference.
Nonvolatile Period—Approximately five years at room temperature.

POWER REQUIREMENTS

Line Voltage—Range 90 to 132 V ac, 180 to 250 V ac.
Line Frequency—48 to 440 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width w/handle	237	9.3
Height w/accessory pouch	174	6.8
Height w/o accessory pouch	120	4.7
Depth, handle not extended	409	16.1
Depth, handle extended	492	19.4
Weight ≈	**kg**	**lb**
Net w/o accessories	5.1	11.5
318AS1 w/accessories	6.7	14.7
338S1 w/accessories	7.2	15.7

ORDERING INFORMATION

318A Logic Analyzer*1
Includes: Power cord (161-0104-00); accessory pouch (016-0697-00); P6107 Probe (1 additional with the S1 configuration) (010-6107-13); P6451 probe, two with the 318A, four with the 338 (010-6451-07); reference guide; operator's manual.
318AS1 Logic Analyzer With Serial Analysis and RS-232 Interface*1
318AF1 Field-Installed Serial Analysis and RS-232*1
338 Logic Analyzer **$5,800**
338S1 Logic Analyzer With Serial Analysis, RS-232, and Nonvolatile Memory **$7,000**
338F1 Field-Installed Serial Analysis, RS-232, and Nonvolatile Memory **$1,500**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Service Manual*1
RS-232 Cable—Order 012-0757-00*1
Service Maintenance Kit—Order 067-1159-01 **$705**
Null Modem Cable—Order 012-0530-00 **$95**

*1 *To order, contact your local Tektronix Sales Office.*

The SONY® /TEKTRONIX® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo Japan. Outside of Japan, the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.

Microprocessor, Digital-Signal Processor, and Bus Support

- **Single-Connection Probe Adapters for Ease of Use and Reliability**
- **Ready-to-Use Mnemonics on Disk, Tape, or ROM Pack**

Tektronix Logic Analyzers offer wide-ranging microprocessor support with a wide selection of single-connection probe adapters and mnemonic disassembly packages.

For custom microprocessors, or microprocessors not listed below, Tektronix offers support through EDM (Extended Define Mnemonics) on the DAS 9100.

Also the Universal Probe Interface Kit (UPIK40) on page 132 is a general-purpose, single-connection probe adapter.

This table summarizes the microprocessor and bus support products offered for the DAS 9200, DAS 9100, and 1240/1241, 1220/25, and the 1205 families of Analyzers.

Micro-processor	Logic Analyzer Family	For Software ORDER	For Probe Adapter ORDER	Acq. Boards Required	Acq. Probes Required	Fastest Clock Rate Supported	Price*1
INTEL MICROPROCESSORS							
8080	DAS 9100	91TM01	Opt 01	2*2	4*9	Max	$550
	1240/41	12RM01	Opt 01	2*4	4*9	Max	$600
8031	DAS 9100	91TM07	Opt 01	2*2	4*7	Max	$550
	1240/41	12RM99 (Opt 03)	UPIK40	2*4	4*7	Max	$575
8039	DAS 9100	91TM10	Opt 01	1*3	3*7	Max	$550
8085	DAS 9100	91TM02	Opt 01	2*2	4*9	Max	$550
	1240/41	12RM02	Opt 01	2*4	4*9	Max	$600
	1220/25	*21	PM404	*20	None		$600
8086	DAS 9200	92DM03	92DM03	*5	None	Max	$1,250
(DIP)	DAS 9100	91TM03	Opt 02*10	2*2	None	8.0 MHz	$2,450
	1240/41	12RM03	Opt 02*10	3*4	None	8.0 MHz	$2,500
8088	DAS 9200	92DM04	92DM04	*5	None	Max	$1,250
(DIP)	DAS 9100	91TM04	Opt 02*10	2*2	None	8.0 MHz	$2,450
	1240/41	12RM04	Opt 02*10	3*4	None	8.0 MHz	$2,500
80186	DAS 9200	92DM05	92DM05	*5	None	Max	$1,250
(LCC/PGA)	DAS 9100	91TM05	Opt 02*10	2*2	None	8.0 MHz	$2,450
	1240/41	12RM05	Opt 02*10	3*4	None	8.0 MHz	$2,500
80188	DAS 9200	92DM06	92DM06	*5	None	Max	$1,250
(LCC/PGA)	DAS 9100	91TM06	Opt 02*10	2*2	None	8.0 MHz	$2,450
	1240/41	12RM06	Opt 02*10	3*4	None	8.0 MHz	$2,500
80286	DAS 9200	92DM08	92DM08	*5	None	Max	$1,600
(LCC/PGA)	1240/41	12RM08	Opt 02*10	3*4	None	10.0 MHz	$2,500
80386	DAS 9200	92DM09	92DM09	*6	None	Max	$1,900
MOTOROLA MICROPROCESSORS							
6800	DAS 9100	91TM21	Opt 01	2*2	4*9	Max	$550
	1240/41	12RM21	Opt 01	2*4	4*9	Max	$600
6801	DAS 9100	91TM28	Opt 01	2*2	4*9	Max	$550
	1240/41	12RM99 (Opt 05)	UPIK40	2*4	4*9	Max	$575
6802	1240/41	12RM22	Opt 01	2*4	4*9	Max	$600
6805E2	1240/41	12RM99 (Opt 06)	UPIK40	2*4	2*7	Max	$575
6805E3	1240/41	12RM99 (Opt 07)	UPIK40	2*4	3*7	Max	$575
6808	1240/41	12RM23	Opt 01	2*4	4*9	Max	$600
6809	DAS 9200	92DM24	92DM24	*5	None	Max	$900
	DAS 9100	91TM24	Opt 01	2*2	4*9	Max	$550
	1240/41	12RM24	Opt 01	2*4	4*9	Max	$600
	1220/25	*21	PM406	*20	None	Max	$600
6809E	DAS 9200	92DM24	N/A*13	*5	None	Max	$900
	DAS 9100	91TM24	Opt 01	2*2	4*9	Max	$550
	1240/41	12RM24	Opt 01	2*4	4*9	Max	$600
	1220/25	*21	PM406	*20	None	Max	$600
68HC11	1240/41	12RM99 (Opt 08)	N/A*11	2*4	3*7	Max	$400
68000	DAS 9200	92DM27	92DM27	*5	None	Max	$1,250*18
(DIP)	DAS 9100	91TM25	Opt 02*10	2*2	None	12.5 MHz	$2,450
	1240/41	12RM25	Opt 02*10	3*4	None	12.5 MHz	$2,500
68000	DAS 9200	91TM27	Opt 2S*17	*5	None	Max	$2,450
(PGA)	DAS 9100	91TM25	Opt 04*10	2*2	None	12.5 MHz	$2,450
	1240/41	12RM25	Opt 04*10	3*4	None	12.5 MHz	$2,500
68008	DAS 9100	91TM26	Opt 02*2	2*2	None	8.0 MHz	$2,450
(DIP)	1240/41	12RM26	Opt 02*10	3*4	None	8.0 MHz	$2,500
68010	DAS 9200	92DM27	92DM27	*5	None	Max	$1,250
(DIP)	DAS 9100	91TM27	Opt 02*10	2*2	None	12.5 MHz	$2,450
	1240/41	12RM27	Opt 02*10	3*4	None	12.5 MHz	$2,500
68010	DAS 9200	91TM27	Opt 2S*17	*5	None	Max	$2,450
(PGA)	DAS 9100	91TM27	Opt 04*10	2*2	None	12.5 MHz	$2,450
	1240/41	12RM27	Opt 04*10	3*4	None	12.5 MHz	$2,500
68020	DAS 9200	92DM31	92DM31	*6	None	Max	$1,900
	1240/41	12RM31	Opt 02*10	3*4	None	20.0 MHz	$2,500

Micro-processor	Logic Analyzer Family	For Software ORDER	For Probe Adapter ORDER	Acq. Boards Required	Acq. Probes Required	Fastest Clock Rate Supported	Price*1
ZILOG MICROPROCESSORS							
Z80	DAS 9200	92DM41	92DM41	*5	None	Max	$900
	DAS 9100	91TM41	Opt 01	2*2	4*7	Max	$550
	1240/41	12RM41	Opt 01	2*4	4*7	Max	$600
	1220/25	*21	PM402	*20	None	Max	$600
	1205	*21	PM302	*20	None	4 MHz	$700
Z8001/3	DAS 9100	91TM42	N/A*11	2*2	4*9	Max	$350
	1240/41	12RM42	N/A*11	3*4	4*9	Max	$400
Z8002/4	DAS 9100	91TM43	Opt 01	2*2	3*9	Max	$550
	1240/41	12RM43	Opt 01	3*4	3*9	Max	$600
TEXAS INSTRUMENTS MICROPROCESSORS							
TMS32020/ 320C25	1240/41	12RM99 (Opt 11)	N/A*11	3*4	5*7	Max	$400
TMS32010	1240/41	12RM99 (Opt 14)	Opt 01	2*4	4*7	Max	$400
HITACHI MICROPROCESSORS							
6301/3	1240/41	12RM99 (Opt 09)	UPIK40	2*4	4*9	Max	$575
64180R0	1240/41	12RM99 (Opt 12)	N/A*11	3*4	5*7	Max	$400
OTHER MICROPROCESSORS							
6502/C02	DAS 9100	91TM63	Opt 01	2*2	4*8	Max	$550
	1240/41	12RM63	Opt 01	2*4	4*8	Max	$600
	1220/25	*21	PM403	*20	None	Max	$600
	1205	*21	PM303	*20	None	4 MHz	$700
1802/4/5/6/ (A/C/AC/BC)	1240/41	12RM99 (Opt 22)	UPIK40	2*4	3*7	Max	$575
F9450	DAS 9200	92DM64	Opt 13*15	*5	None	Max	$2,400
	DAS 9200	92DM64	Opt 14*16		None	Max	$2,900
	DAS 9100	91TM62	N/A*11	2*2	3*9	Max	$350
	1240/41	12RM62A	N/A*11	3*4	3*9	Max	$400
1750A	DAS 9200	92DM64	*14	*5	None	40.0 MHz	$900
	DAS 9200	92DM64	Opt 10	*5	None	40.0 MHz	$1,650
	DAS 9200	92DM64	Opt 11	*5	None	40.0 MHz	$1,550
	DAS 9200	92DM64	Opt 12	*5	None	40.0 MHz	$1,650
	DAS 9100	91TM64	N/A*11	2*2	*16	10.0 MHz	$350
NSC800	DAS 9100	91TM71	Opt 01	2*2	4*7	Max	$550
	1240/41	12RM71	Opt 01	2*4	4*7	Max	$600
GM ECM	1240/41	12RM99 (Opt 01)	UPIK40	2*4	4*9	Max	$575
GENERAL PURPOSE MICRO-P	1205	*21	PM301	*20	None	*22	$700

BUS	Logic Analyzer Family	For Software ORDER	For Probe Adapter ORDER	Acq. Boards Required	Acq. Probes Required	Fastest Clock Rate Supported	Price*1
DEC							
VAXBI	DAS 9100	12RM99	VB100	*19	*19	Max	$9,250
	1240/41	(Opt 13)	012-1164-00	3*4	6*9	Max	
UNIBUS	DAS 9100	91TM51	N/A*11	2*2	4*9	Max	$350
Q-BUS	DAS 9100	91TM52	N/A*11	2*2	4*9	Max	$350
OTHER							
GPIB; ASCII; EBCDIC	DAS 9100	91TM53	Opt 01	1*3	2*9	Max	$380
GPIB	1240/41	12RM99 (Opt 04)	*12	2*4	2*9	Max	$400
STD	1220/25	*21	PM405	*20	None	Max	$600

*1 *Price for Software and Probe Adapter (if available)—probes and boards not included.*
*2 *Requires one 91A24 and one 91AE24.*
*3 *Requires one 91A24.*
*4 *1240D2 boards.*
*5 *Works with 92A60 and 92A90.*
*6 *Requires 92A90.*
*7 *P6460s are always required.*
*8 *P6460s are required for CMOS versions.*
*9 *Can be used with P6460s or P6462s.*
*10 *PM200 personality module required.*
*11 *No configured probe interface available.*
*12 *Uses GPIB lead set (103-0209-00).*
*13 *Use 92A60/90 General purpose lead set (standard with 92A60 or 92A90) and a 003-0801-00 IC clip. Order Option 1D to delete 6809 probe adapter.*
*14 *Comes with adapter for Emulator PIAs (8300P53 options). Order Option 10 for Flying Lead PIA with grabber tips, Option 11 for stripped and tinned Flying Lead PIA, Option 12 for DIN cable PIA.*
*15 *Use 92DM64 Option 13 for non-MMU applications.*
*16 *Use 92DM64 Option 14 for MMU-based applications.*
*17 *Depends on 1750A implementation.*
*18 *Substitutes a PGA probe adapter.*
*19 *Refer to DAS 9100 section for further information.*
*20 *Does not apply.*
*21 *Software is included in/with probe adapter.*
*22 *Fastest bus rate supported; PM301 has a maximum bus rate of 4 MHz.*

ACQUISITION PROBES

P6440 State Probe—24 Channels of Data Acquisition, 3 Clocks/Qualifiers, External Trigger. For use with 1205 Logic Analyzer. Order P6440 **$400**

P6441 Timing Probe—8 Channels of Data Acquisition, 1 External Clock, 1 External Trigger. For use with 1205 Logic Analyzer. Order P6441 **$450**

P6442 General Purpose Probe—16 Channels of Data Acquisition, 4 Clocks, 2 Qualifiers, 6 External Trigger Inputs. For use with 1220/25 Logic Analyzer. Order P6442 **$500**

P6451 8-Channel Data Acquisition Probe—For use with 300 Series instruments (right-angle connector to analyzer). Order P6451 (010-6451-07)*[1]

P6452 8-Channel Data Acquisition Probe—For use with DAS 9100 mainframes, DAS 91A32/91A08. Order P6452 **$730**

P6453 4-Channel Data Acquisition Probe—High-speed probe for DAS 91A04A/91AE04A. Order P6453 **$1,560**

*[1] *Contact your local sales office for information.*

P6460 8/9-Channel Data Acquisition Probe—For use with 1240D1, 1240D2, DAS 91A24/91AE24. Order P6460 **$700**

P6462 8/9-Channel TTL Only Data Acquisition Probe—For use with 1240D2, DAS 91A24/91AE24/91A32. Order P6462 **$340**

P6461/P6461E 8-Channel Data Acquisition Probe—For use with DAS 92A16/92A16E (P6461E has no clock or Qualifier Channels). Order P6461 or P6461E **$1,370**

PATTERN GENERATOR PROBES

P6455 TTL/MOS Pattern Generator Probe 8-Channels—For use with DAS 91P16/91P32. Order P6455 **$575**

P6456 ECL Pattern Generator Probe 8-Channels—For use with DAS 91P16/91P32 modules. Order P6456 **$575**

P6457 TTL/MOS Pattern Generator Probe, 4-Channels, Individually Tri-Stateable—For use with DAS 91P16/91P32. Order P6457 **$575**

P6463 TTL/CMOS Pattern Generator Probe—9-Channels at 50 MHz or 16-Channels at 25 MHz. For use with 91S32/92S32. Order P6463 **$1,000**

P6464 50-MHz Pattern Generator Probe—For use with DAS 91S16/92S32. Order P6464 **$1,350**

P6465 50—MHz Pattern Generator Probe—8 Data Channels, 1 clock and 1 Rz R1 strobe for use with DAS 92S16/92S32. Order P6465 **$1,680**

OTHER PROBES

P6454 100-MHz Clock Probe—For use with DAS 91A08 (max of one P6454 per DAS system). Order P6454 **$265**

P6041 Passive Probe*—Used as Sync out cable, 50 Ω Termination. Order P6041 **$65**

Controlled-Width Probelet—Use with DAS 91S16/91S32 to create programmable pulses. Requires two P6464 channels to create one programmable channel. Order 020-1392-00 **$150**

PROBE APPLICATION MATRIX

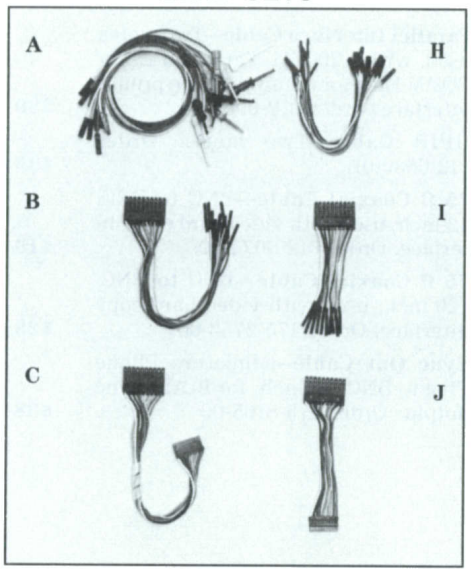
PRODUCT	P6440	P6441	P6442	P6451	P6452	P6453	P6454	P6455	P6456	P6457	P6460	P6461/E	P6462	P6463	P6464	P6465
92A16, 92A16E											✓	✓				
92S16, 92S32														✓	✓	✓
91A24, 91AE24											✓		✓			
91A32					✓								✓			
91A08					✓		✓									
91A04A, 91AE04A						✓										
91P16, 91P32								✓	✓	✓						
91S16, 91S32														✓	✓	
1240D1											✓					
1240D2											✓		✓			
1220/1225			✓													
1205	✓	✓														
338, 318				✓												

LEAD SETS

A. Individual Hook-Tip Lead Set—10 leads, 16 inch, color coded with E-Z-Micro Hook Tips. Order 012-0670-00 **$85**

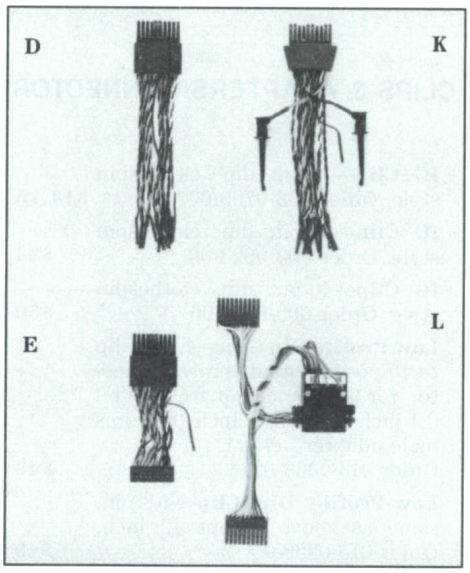
B. Flying Lead Set—10-wide comb, 10 inch, color coded, connects to 0.025-inch square pins, grabber tips not included. Order 012-0747-00 **$65**

C. Harmonica Lead Set—10-wide comb to 10-position single-row connector, for 0.025-inch square pins on 0.1-inch centers, 10 inch, color coded. Order 012-0800-00 **$34**



D. Pattern Generator Lead Set—10 + 2-wide comb, 9 inch, twisted pairs, color coded, connects to 0.025-inch square pins, grabber tips not included. Used with P6455, P6456, P6457 pattern-generator probes. Order 012-1053-00 **$110**

E. High-Speed Pattern Generator Lead Set—10 + 2 wide comb to 20-position double-row connector, for 0.025-inch square pins on 0.15-inch centers, 5 inch, color coded. Used with P6455, P6456, P6457 pattern generator probes. Order 012-0551-00 **$130**

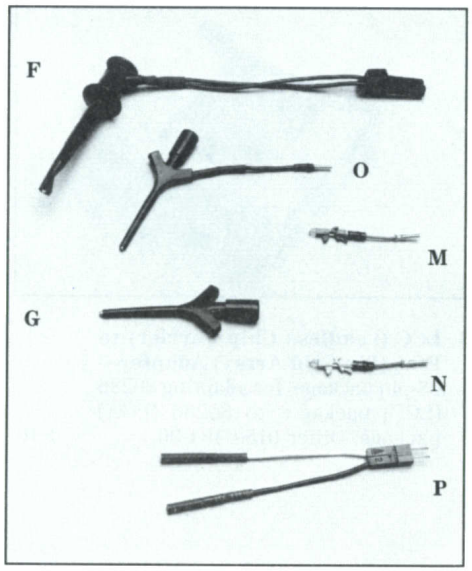


F. Sense Leads—Package of ten, 2-wide comb to Pomona Hook Tip, 5 inch, black for ground or VL. Order 012-0989-01 **$115**

G. Grabber Tip—Package of 12, for general-purpose probing with various lead sets.
(Single-sided grabber tips)
Order 020-1386-00 **$41**
(Double-sided grabber tips)
Order 020-1456-00 **$90**

*1 **Flying Lead Set**—10 inch, 10 channel, color coded. For use with the P6440, P6441 or P6442 Data Acquisition Probes.
Lead Set with Black Ends—Order 174-0752-00 **$30**
Lead Set with Red Ends—Order 174-0763-00 **$30**
Lead Set with White Ends—Order 174-0764-00 **$30**

*1 *Not shown.*
*2 *Contact your local sales office for information.*



H. Individual Lead Set—10 leads, 8 inch, color coded, connects to 0.025-inch square pins, grabber tips not included. Order 012-0655-02 **$175**

*1 **Individual Lead Set**—10 leads, 16 inch, color coded, connects to 0.025-inch square pins, grabber tips not included. Order 012-0655-01 **$175**

I. Flying Lead Set—10-wide comb, 5 inch, color coded, connects to 0.025-inch square pins, grabber tips not included. Order 012-0987-00 **$46**

J. Harmonica Lead Set—10-wide comb to 10-position single-row connector, for 0.025-inch square pins on 0.1-inch centers, 5 inch, color coded. Order 012-0968-00 **$105**

K. Pattern Generator Lead Set—10 + 6-wide comb with VH and VL Pomona Hook Tips, 9 inch, twisted pairs, color coded, connects to 0.025-inch square pins, grabber tips not included. Used with P6455, P6456, P6457 pattern generator probes. Order 012-1053-00 **$110**

L. GPIB Adapter—Two 10-wide combs to IEEE Standard 488 Bus Connector, 10 inch. Order 103-0209-00 **$220**

M. High-Speed Grippers—Package of ten, 1.75 inch, for flat packages with 0.05-inch lead spacing, use with P6453 or P6454.
Order 195-1943-06 **$110**

N. High-Speed Grippers—Package of ten, 1.75 inch, for Dip packages with 0.1-inch lead spacing, use with P6453 or P6454.
Order 195-2234-06 **$110**

O. High-Speed Clock Lead—With grabber tip, package of two, for use with P6453 or P6454.
Order 195-3659-02 **$16.50**

P. Lead Set—For use with Podlets. Acquisition probes P6461/E and HS8. Order 196-3047-00*2
Pattern generator probes P6464/P6465. Order 196-2963-00 **$9.75**

*1 **Pattern Generator Flying Lead Set**—10 inch, 17 twisted pair leads, color coded. For use with the P6463 Pattern Generator Probe. Order 012-1236-00 **$32**

CABLES

RS-232 Cable—Male-to-female, 20 inch, wires: 1-1, 2-2, 3-3, 4-4, 5-5, 6-6, 7-7, 8-8, 11-11, 12-12, 15-15, 17-17, 19-19, 20-20, 22-22. Used with 1200C01 modem interface DAS 9200 mainframe to terminal or DAS 9100 line printer and communications interface. Order 012-0911-00 **$100**

RS-232 Cable—Male-to-female, 2 meter, 25 wires: 1-1, 2-2, 3-3, thru 25-25. General purpose. Order 012-0815-00 **$85**

Null Modem Cable—Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-5, 5-4, 7-7, 8-20, 11-11, 12-12, 19-19, 20-8. General purpose. Order 012-0820-00 **$405**

Null Modem Cable—Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-8, 5-8, 6-20, 7-7, 8-4, 8-5, 20-6. Used with 1200C01 Serial Printer interface. Order 012-0530-00 **$95**

Parallel Interface Cable—Two meter, used with 1200C11 Parallel Printer COMM Pack for Centronix type printer interface. Order 012-0997-00 **$80**

GPIB Cable—Two meter. Order 012-0630-01 **$95**

75 Ω Coaxial Cable—BNC to BNC, 42-inch, used with video hard copy interface. Order 012-0074-00 **$19**

75 Ω Coaxial Cable—BNC to BNC, 120 inch, used with video hard copy interface. Order 175-2753-00 **$28**

Sync Out Cable—Miniature Phone Plug to BNC, 79 inch, for 91A24 sync output. Order 175-8165-00 **$38**

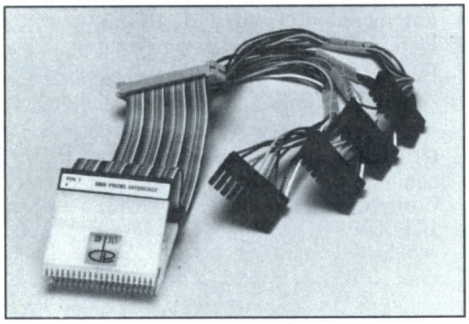
91AE04A Coaxial Jumper Cables Replacements—3 inch , SMA connectors to connect 91A04A to 91AE04A. Order 175-6425-00 **$18**

91AE24 Jumper Cable Replacements—Package of seven, twisted pair, 2-position connectors, 3 inch. Order 175-8167-00 **$4.80**

Probe Extender Cable—Male to Female 34-position double-row connectors compatible with P6452, P6463, P6455, P6456, P6462, 6 feet. Order 012-1012-01 **$125**

Flat Cable Mounts—Adhesive Back for securing and organizing probes with flat ribbon cables. Order 343-1048-00 **$.95**

IC CLIPS & ADAPTERS/CONNECTORS



A. UPIK 40, Universal Probe Interface Kit—For 40-pin dip packages. Allows user to configure interconnect from 6 probes or less to a clothespin style 40-pin IC clip. Order UPIK 40 **$175**

40-Pin Male Adapter—40-position double row header with 0.025-inch square pins on 0.1-inch centers, interfaces the PM 101 or flying lead sets to low-profile dip clip above. Order 380-0560-05 **$16.50**

40-Pin Dip Socket Female Adapter—40-position double-row head with 0.025-inch square pins on 0.1-inch centers to 40-pin dip socket, for interfacing 40-pin low-profile dip clips to PM 100 series probes. Order 380-0647-01 **$40**

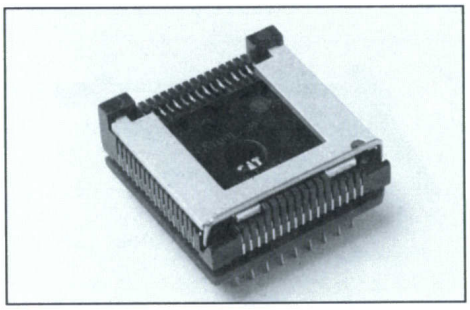
IC Clip—16-pin dip, clothespin style. Order 003-0709-00 **$14.75**

IC Clip—24-pin dip, clothespin style. Order 003-0823-00 **$34**

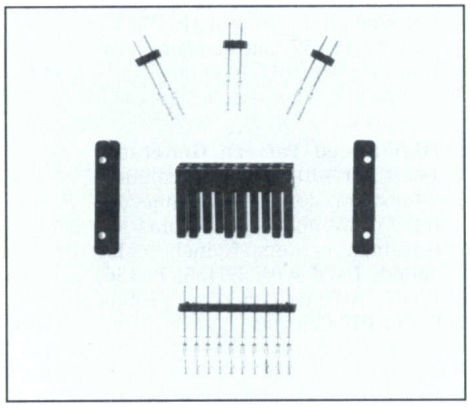
IC Clip—40-pin dip, clothespin style. Order 003-0801-00 **$50**

Low Profile Dip Clip—40-pin dip to 40-position double row connector, for 0.025-inch square pins on 0.1-inch centers, 4 inch (requires male adapter below). Order 015-0339-02 **$49**

Low-Profile Dip Clip—40 pin, same as above except 12 inch. Order 015-0339-00 **$49**



B. LCC (Leadless Chip Carrier) to PGA (Pin Grid Array) Adapter—68-pin package, for adapting 80286 (LCC) packages to 80286 (PGA) package. Order 015-0494-00. **$36**



C. Circuit Board Mounted Probe Connector Kit—10 + 6-wide comb to 0.025-inch square pins on 0.15-inch centers, with mounting tabs, for PC mounting, mounting hole dimensions 0.80 inch wide X0.95 inch long. Interfaces to the following probes: P6452, P6455, P6456, P6457, P6460, and P6462. Seven piece kit. Order 020-1027-00 **$36**

DAS 9200

Cable Clamp—RS-232 Cable Grounding Clamp. Used for EMI shielding. Order 334-0399-00*1

Circuit Board Ejector Tools—For removal of circuit boards from the DAS 9200 Mainframe (2 required). Order 105-0985-00 **$2.50**

Deskew Adapter—For use with the DAS 92A60/90, to deskew the channel groups. Order 010-0456-00 **$150**

General Purpose Leadset—For use with the DAS 92A60/90, flying leads can be connected to 0.025 square pins or optional grabber tips. Order 012-1165-00 **$450**

Podlet Gang Connector—For use with P6461/P6461E, 10 wide, pkg of 2, NOT for use with P6464 or P6465. Order 020-1442-00 **$35**

Retainer Clamps—Kit of 4. (P6461E) Order 020-1483-00 (P6460/P6464/P6465, DAS 9200. Order 020-1484-00 **$35**

MEDIA

For DAS 9200, DAS 9100, and 1240/1241.

Flexible Disk—360K, 5.25-inch, 48 TPI, package of 10. Order 119-1583-01 **$60**

Tape Cartridges, DC-100 Type—Package of five used on DAS 9100 Option 01. Order 119-1350-01 **$185**

Mnemonic Conversion Tape, DAS 9100—Converts mnemonic and all type files from DAS firmware versions 1.05 and 1.07 to compatibility with DAS firmware versions 1.09 or 1.11. Order 062-6705-00 **$75**

8K RAM Pack—With lithium iodide battery back-up, used with 1240/1241. Order 12RS01 **$300**

64K RAM Pack—Lithium iodide battery back-up, used with 1240/1241. Must have firmware version 5-2 or higher. Order 12RS02 **$500**

32K EPROM Pack—Used with 1240/1241. EPROMSs not included. Order 12RS11 **$85**

32K EPROM Pack—Used with 1240/1241, four 68764 or 68766 EROMs included. Order 12RS12 **$300**

*1 *Contact your local sales office for information.*

DAS 9100

Service Maintenance Kit—Includes board and cable extenders for DAS modules, power supplies, CRT, and keyboard. Order 067-0980-01 **$1,375**

Set-Up and Hold-Time Test Fixture—Order 067-1037-00 **$1,285**

High-Speed Acquisition Test Fixture—For verification of DAS 91A04, DAS 91AE04, DAS 91A04A, and DAS 91AE04A modules. Order 067-1139-00 **$280**

Circuit Board Ejector Tool—For removing DAS 9100 module cards. Order 214-3154-00 **$5.75**

High-Speed Lead Connectors—Package of ten, gold-plated contact pins that interface to podlet lead receptacles on P6453 or P6454. Order 131-2729-02 **$30**

Diagnostic Lead Set—10-wide comb to 10-wide comb, and two-wide ground jumper, 10-inch, for connecting pattern generator probes to data acquisition probes. Order 012-1000-00 **$80**

RACKS AND RACKMOUNT KITS

Rackmount Kit—For DAS 9100. Order 016-0463-00 **$205**

Rackmount Kit—For DAS 9200. Order 016-0845-00 **$450**

Rackmount Kit—For 1240/41. Order 016-0789-00 **$405**

Rackmount Kit—For 9XHS8. Order 016-0884-00*1

Rack—Instrumentation Rack with 115 or 220-V power controller. For use with all rackmountable Logic Analyzers.
For 115 V. Order 437-0241-00 **$3,815**
For 220 V. Order 437-0244-00 **$4,240**

Panels—Blank Panels for Instrument Rack.
1¾ inch. Order 333-1351-00 **$16**
3½ inch. Order 333-0997-00 **$27**
5¼ inch. Order 333-0999-00 **$12.25**
7 inch. Order 333-1352-00 **$13**
8¾ inch. Order 333-0998-00 **$14.25**
10½ inch. Order 333-0996-00 **$14.75**

1240/1241

Service Maintenance Kit—Includes 1240 Service Manual with 1241 Service Addendum, 12RD01 Diagnostic ROM Pack, Diagnostic Lead Sets, Extender Card for Acquisition Cards, and Extender Card for the Trigger, Display, and Processor Cards. Order 067-1103-03 **$2,020**

Diagnostic Lead Set, 1240/1241—10-wide comb with 2-wide ground to 12-position double-row connector, for 0.025-inch square pins on 0.1-inch centers, 10 inch, color coded. Order 012-0556-00 **$65**

1220/1225/1205

Demo/Test Circuit—For use with the 1220/25 and the 1205. A convenient tool to aid in gaining experience and confidence with the use of a Logic Analyzer. Can also be used to do a simple Demonstration of the uses of a Logic Analyzer. Order 671-0049-00 **$75**

CARTS

92Cart—AnthroCart for DAS 9200. Order 92Cart **$355**

K217 Cart—See Accessories section for complete description. **$355**
For DAS 9100, 1240/41, and 1220/25. Order K217 **$510**

OTHER

Accessory Pouch—Convenient for carrying manual and other accessories for 1240/1241, 1220/25, and DAS 9100 Logic Analyzers. Order 016-0707-00 **$65**

SEMICONDUCTOR TEST SYSTEMS

CONTENTS

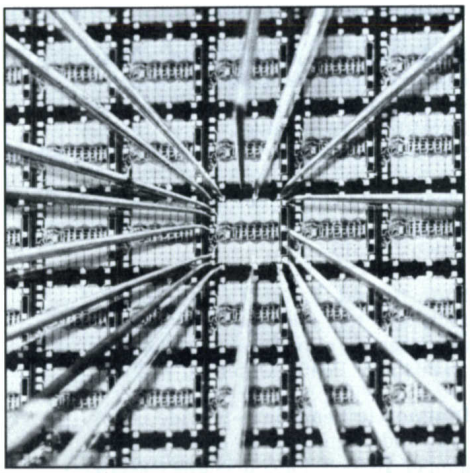
LT-1000 VLSI Logic Test System . . 135

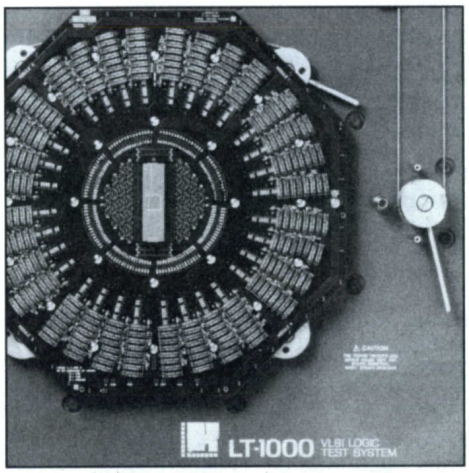
With the introduction of the LT-1000 VLSI Logic Test System, Tektronix Semiconductor Test Systems Division initiates a new era of cost-effective testing of high-speed, high-pin-count VLSI circuits. With all new hardware and software designed "from the ground up," this system was developed specifically to meet the demands of testing CMOS application-specific devices (ASICs)

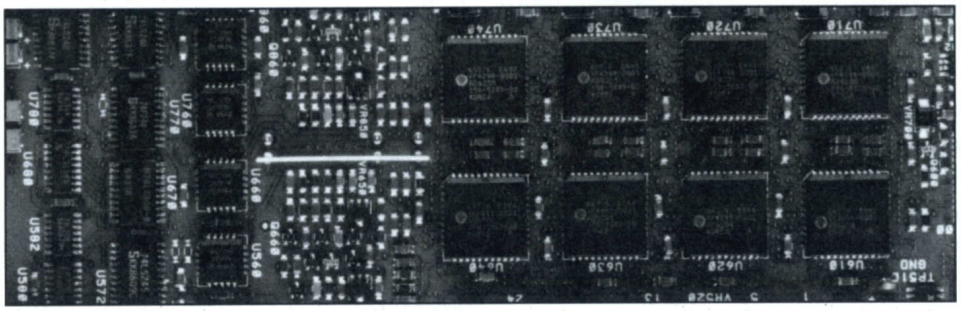
Tektronix test systems are known throughout the electronics industry for their innovative solutions to the latest testing challenges. Each successive generation of semiconductor devices boasts higher speed, more pins, more functions per chip, and more complex testing requirements. With the LT-1000, Tektronix STS again meets the new challenges of the industry with a new approach to the complexities of ASIC test. Backed by the same commitment to excellence as other Tektronix products, this new system offers time saving features in such critical areas as program development, device handling and test, system calibration, and maintenance, while lowering capital-equipment costs through creative economy of design.

While the LT-1000 marks a dramatic departure from the architecture of the previous Tektronix systems in the S-3200 product line, it also represents a new chapter in a continuing effort to anticipate and fill the needs of the evolving device-testing market.

In the beginning, our first-generation automated semiconductor tester was designed to test the largest LSI devices in use at the time (four- and eight-bit microprocessors, 1K memories, and peripheral chips). Later systems offered improved device characterization and were designed for quality control in production test environments. Next we tackled the challenge of testing high-speed logic and solving the unique problems associated with subnanosecond technologies. Then, we offered a full range of production-oriented enhancements to truly put Tek quality into production. Now, with the







LT-1000, Tektronix offers a cost-performance breakthrough in the testing of high-speed, high-pin-count, CMOS VLSI.

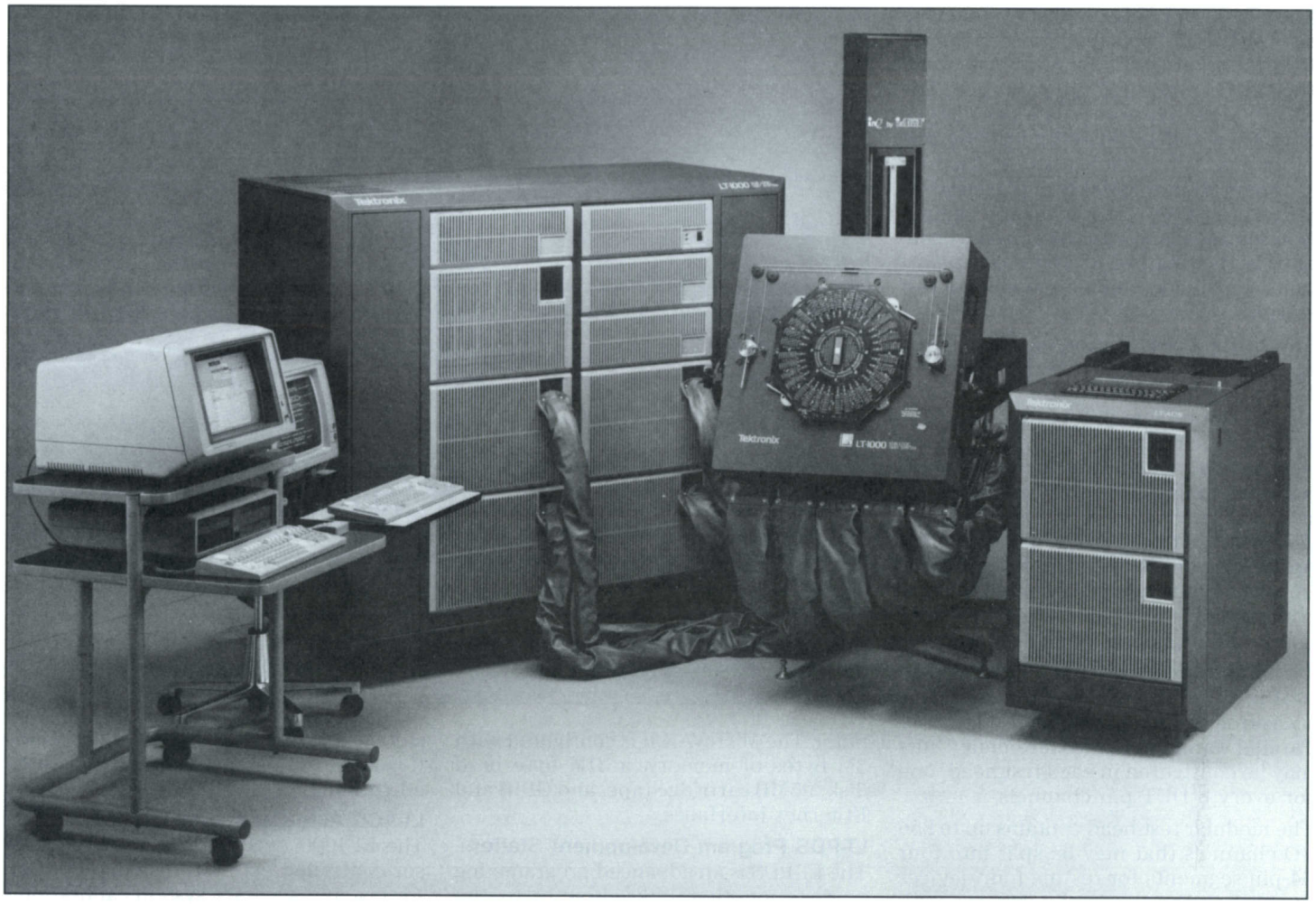
Tektronix provides the hardware, software, training, and applications-engineering support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources, not as insurmountable problems.

Every Tektronix system, whether it's one of the field-proven S-3200 products or the innovative LT-1000, is designed with the user in mind. The LT-1000 software is a powerful, menu-driven language set that can interface directly with CAE design sources and runs on hardware independent of the tester and devoted exclusively to program development.

All Tektronix systems feature highly sophisticated data reduction and graphics, which make the test results manageable and easy to understand.

We offer analog and digital capability to meet the latest test requirements presented by new and increasingly complex devices. In fact, many "captive" device manufacturing facilities use Tektronix systems for just this reason. Tektronix is also a device manufacturer and has been testing its own ICs and hybrids for years. As a company, we have developed expertise and in-depth understanding of complex testing.

At Tektronix, we've built on our past experience and knowledge about device testing and tester design to create products that can help you meet your testing challenges—today and in the future.



LT-1000 VLSI Logic Test System

- **Optimized for High-Speed,**
- **High Pin-Count ASIC Devices**
- **Reduced Production Cost-Per-Test**
- **Independent Auto-Calibration**
- **Rapid Off-Line Program Development**

The LT-1000 VLSI Logic Test System represents a price-performance breakthrough for high-speed, high pin-count ASIC device testing. Each component, hardware and software, was designed for maximum efficiency and reduced cost per test. By balancing the tester-per-pin and shared-resource architectures between the system's integrated pin electronics and support rack instrumentation, the cost and size of hardware in the LT-1000 is kept at a minimum. Test-head fixturing and interfacing capabilities are designed for maximum throughput.

Unique approaches to system calibration and program development using system-independent support units maximize the utility of those units and eliminate costly redundancy. All of these features translate into savings in all of the critical test cost areas: initial capital investment, device handling and testing time, program development time, and set-up time between production runs, as well as routine and unscheduled maintenance.

The innovative system architecture and software of the Tektronix LT-1000 VLSI Logic Test System were strategically designed for high-volume testing of application-specific VLSI circuits. The LT-1000 meets all the testing requirements for gate arrays, standard cell ICs and custom and semicustom devices at a price substantially lower than the general-purpose testers commonly used in these applications.

The LT-1000 VLSI Logic Test System is capable of testing the ac, dc, and functional performance of VLSI circuits with up to 256 pins at speeds up to 50 MHz. The system was optimized for the demands of CMOS technology, but with sufficient flexibility to be adapted to other processes as well.

The LT-1000 VLSI Logic Test System consists of the LT-1000 Test Station, the LT-PDS Program Development Station and the LT-ACS Auto-Calibration Station. The LT-PDS is used to access data from design databases and to write and debug test programs. The LT-ACS uses external instrumentation to quickly and accurately perform system verification and calibration routines. A key to the system's economy is the sharing of system's support units' capabilities among a number of test stations.

The LT-1000 Test Station design is based on a "mixed" architecture that combines the strengths of both tester-per-pin and shared-resource architectures. The DUT interface circuitry required at each device pin (including drivers, comparators, timing generators, and data formatters) is condensed into two custom CMOS monolithic integrated circuits. This approach requires less hardware which, in turn, results in a more compact, more maneuverable test head, lower hardware costs, and higher reliability.

Dc parametric test times are reduced by making simultaneous parametric measurements on multiple pins. Up to 32 Parallel Parametric Measurement Units may be configured in each test head, one for every 8 DUT pin channels.

The modular test head contains up to 256 I/O channels that may be split into four 64-pin segments for testing four devices in parallel. For applications where multiple test heads are required, a second test head is available as a system option.

The compact design of the test head allows positioning on any axis for mounting to commercial manipulators or adaptation for manual insertion. The test head interfaces to a variety of wafer probers and automatic device handlers for high throughput, plus fixturing can be changed quickly and easily to save time between production runs. Positioning keys and locking devices make such changes virtually error-free and ensure high-integrity signal transmission.

The test head is linked to a double-width, short-frame system support rack that houses the system controller and the shared-resource components, which provide the signals, voltages, and instructions to the DUT through the test head pin electronics. Each function provided by the rack was designed for maximum economy and maximum throughput. For example, throughput is enhanced by 256K pattern memory which is loaded through a fast direct memory access (DMA) channel to a MicroVAX II™ computer. The MicroVAX II is configured with 3M bytes of memory, a 31M byte hard disk, 95MB cartridge tape, and GPIB and Ethernet interfaces.

LT-PDS Program Development Station

The LT-PDS is an advanced programming workstation that links directly to the design workstation. An automatic test program generator running on the LT-PDS converts test vectors and other data extracted from CAE design databases. These are combined with user inputs into a test program using predefined test program skeletons and rules specific to the process technology being tested.

A highly interactive, multiwindow, bit-mapped environment allows the test engineer to fine tune programs quickly and efficiently using intelligent editors and graphical debugging aids such as timing diagrams. These programming tools reduce test development time to a matter of hours instead of days or weeks, which results in dramatic time and cost savings. And, to ensure maximum utilization, a single LT-PDS may be used to develop and debug programs for several test stations.

LT-HOST

A software system host called LT-HOST may be added to the Ethernet network which links the Program Development Stations and LT-1000 Test Stations. The LT-HOST provides centralized data storage and test data analysis, data reduction and test floor management software, all running on a VAX/VMS CPU.

LT-ACS Auto-Calibration Station

The LT-1000 ACS provides microprocessor-controlled external instrumentation for fast and accurate system calibration. Physically linked to the test head during calibration, the LT-ACS uses a single, retractable probe and one signal path to measure system timing, skew, and dc parametric performance. The LT-ACS is controlled by the LT-1000 central processor during calibration and communicates tabulated data back to the system for interpolation and error correction.

A system verification procedure examines the system for gross failures and deviations from published specifications. A fully automatic calibration procedure brings the system up to specified performance levels without manual service adjustments. The LT-ACS is capable of probing the actual DUT fixture, ensuring a fully corrected signal path to the DUT pin.

The accurate, efficient verification and calibration procedures of the LT-ACS save valuable test time and result in higher production yields. And, as with the LT-PDS, a single LT-ACS unit can service many LT-1000 testers for additional hardware cost savings.

COMMUNICATIONS PRODUCTS

CONTENTS

Television Products 138
Fiber Optic TDR Cable Testers . . . 155
Metallic TDR Cable Testers 157
Communications Network Analyzers 159
Spectrum Analyzers 162

Communications Products are quality instruments designed to test, time, measure, and monitor a variety of television, RF, fiber optic, and data communications network signals.

Electronic communications continue to impact mankind through newer and better equipment and applications. We are proud to be at the leading edge of these new technological opportunities.

Spectrum Analyzers

In the last year, the Tektronix Frequency Domain Instrumentation (FDI) division introduced four new spectrum analyzers and added Remote-Site testing capability to the TekSPANS software line.

The communication industry demands high-performance analysis both in the lab and in the field. To meet the needs of the industry, we offer the 2750 Series and 490 Series covering baseband frequencies through 325 GHz. The low cost, portable 2710 offers unprecedented measurement convenience and covers frequencies from 10 kHz to 1.8 GHz.

To meet the needs for system automation and remote site control, we offer GRASP, EMI, and Remote Site Monitoring software. GRASP improves the accuracy, repeatability, and the speed of the 2750 Series and 490 Series spectrum analyzer measurements, and this software supports a variety of popular controllers. EMI software, also used with the 2750 Series (except the 2754) and the 490 Series spectrum analyzers, economically automates VDE, FCC, and MIL-STD tests. Remote Site Monitoring software contains many of the GRASP functions in addition to remote site measurement capabilities, and it can be used with the 2750 Series and 490 Series spectrum analyzers.

Because of your need for measurement versatility, we offer the 7000 Series spectrum analyzer plug-ins. These easy-to-use plug-in models cover 20 Hz to 2.5 GHz, with individual ranges appropriate for applications from audio/baseband to microwave measurements. A variety of features let you select the capability you need. They share the versatility that is basic to the Tektronix plug-in concept—there are over 30 other test and measurement plug-ins.

To meet your demands for high-performance millimeter applications, we offer the WM490 Series of waveguide mixers. Calibrated amplitude and frequency measurement from 18 GHz to 325 GHz are made possible when coupled with the 490 Series and the 2755/2755P spectrum analyzer.

Television

The Television Products Division continues meeting the customer's needs for high performance and low-cost test, measurement, and monitoring equipment. The 1720 Vectorscope and 1730 Waveform Monitor offer more performance than the products they replaced or the competitive products on the market, and at a lower price. Also in the high performance/low price arena is the TSG-170A Test Signal Generator and the SPG-170A Sync Generator.

More and more television stations are broadcasting programs with stereo audio. Helping them achieve and maintain audio quality are the 751 BTSC Aural Modulation Monitor/Decoder, the 760 Stereo Audio Monitor, and the AVC-20 Audio Vector Converter.

Component technology continues impacting the television industry. Fulfilling the needs of this emerging technology are three component products from Tektronix. The WFM-300 Component Analog Waveform Monitor, with its innovative "Lightning" display, the TSG-300 Component Analog test signal generator featuring the unique Bowtie gain and timing test signal, and the 650HR C Component Picture Monitor.

Communication Network Analyzers

For 1988, Tektronix Communications Network Analyzers division introduces a new line of metallic time domain reflectometers (TDRs), a new local area network analyzer and fault locator, and the world's first auto-masking optical TDR.

The 1502B and 1503B metallic TDR cable testers offer improved performance and ease of use, while retaining the versatility and ruggedness for which Tektronix TDRs are renowned. Coupled with lighter weight and lower price, these instruments provide today's most cost-effective means of testing cables from aircraft cabling to underground communications cables.

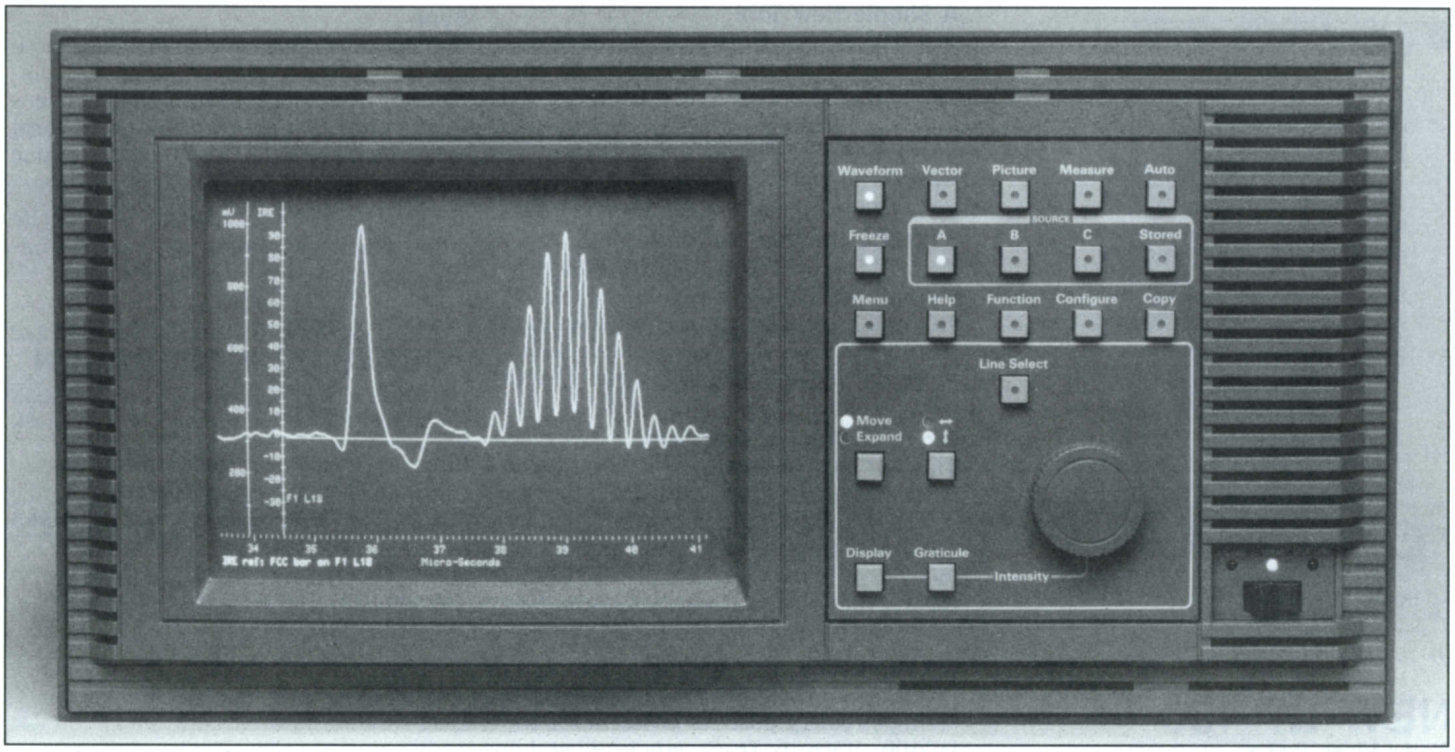
The TMA802 is a comprehensive LAN media analyzer. It quickly and economically tests any IEEE 802 local area network, while the network is in operation. In seconds, the TMS802 accurately evaluates the condition of the cable and monitors network traffic load.

For determining splice locations and loss on singlemode fiber optic cables, Tektronix' new OF235A is unsurpassed. The world's first optical TDR with full automatic masking also features dual switchable wavelengths, selectable pulse widths, ease of use, and rugged portability.

TELEVISION PRODUCTS

CONTENTS

NEW VM 700 Video Measurement Set 139
NEW DP-100 Digital Video Probe . 140
NEW TSG271 TV Generator 140
SPG-170A NTSC Sync Generator . 141
TSG-170A NTSC Television Generator 141
ECO-170A Synchronous Changeover 141
1410R Series Test Signal Generators 142
1910 NTSC Digital Generator 142
110-S Video Synchronizer 143
118-AS Audio Synchronizer 143
1434 Video Noise Generator 144
1430 Random Noise Measuring Set 144
1440 Automatic Video Corrector 144
R148/R148-M PAL Test Signal Generators 144
TSG-300 Component Television Generator 145
WFM-300 Component Television Waveform Monitor 145
NEW 1705 Spectrum Monitor 146
1710B Series Waveform Monitors . 146
1720 Series Vectorscopes 147
1730 Series Waveform Monitors . . 147
1740 Series Waveform/Vector Monitors 149
1750 Series Waveform/Vector Monitors 149
1480 Series Waveform Monitors . . 150
R520A Series Vectorscopes 150
751 BTSC Aural Modulator 151
760 Stereo Audio Monitor 152
AVC-20 Audio Vector Converter . . 152
1450 Series Television Demodulators 153
650HR Series Color Picture Monitors 154
650HR-C Series Component/ Composite Picture Monitors . . . 154



VM700 Video Measurement Set

NEW VM700

Video Measurement Set

- **Automatic Monitoring**
- **User-Programmable Functions**
- **Digital Waveform Monitor/Vectorscope**
- **Hard Copy Capability**

The VM700 is a complete video monitoring and measuring instrument which can be used for automatic monitoring, as well as for manual measurements. The user can select a display of numeric values to confirm the quality of the signal path, or may select graphic displays for more detailed analysis.

Automatic Video Measurement Set

The VM700 makes most standard tele-video measurements automatically, including those specified in RS-250B/EIA-250C, NTC-7, and RS-170A. These measurements can be compared with user-defined limits and an alarm message generated when these limits are violated.

New graphic displays are provided for measurements such as signal-to-noise ratio and group delay, enabling the user to better understand (and improve) the transmission path.

User-Programmable Functions

Any sequence of operations may be identified with a user-defined function. For example, the measurements to be made on a transmitter demodulator output could be identified with a function labeled DEMOD. A technician would simply select this function to make all measurements, including a print-out.

Digital Waveform Monitor/Vectorscope

For more detailed analysis of the waveform, the actual signal may be displayed and additional measurements made manually.

In waveform mode, cursors are available to aid in measuring time, frequency and amplitude. These cursors allow a very quick and precise location of the 10%, 50%, or 90% points on any transition.

The WAVEFORM DISPLAY can be expanded around any point both vertically and horizontally. Because the data is digitized, the display remains bright at all expansion factors. The axes automatically expand with the waveform, so all units are correct as displayed.

The VECTOR DISPLAY mode provides the normal vectorscope display. The vectors may be rotated or expanded, with the rotation angle and gain values displayed numerically on the screen.

Line Select can be used to quickly specify any line for display or automatic measurement.

Hard Copy

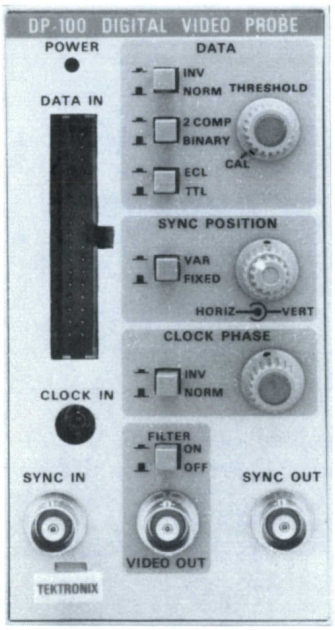
All information on the screen may be printed on printers supporting Epson® or Postscript® graphics via the standard RS-232C interface. Automatic measurement results can be printed on most ASCII printers using the same interface.

Picture Mode

The signal source can be quickly verified using the picture display, and any line may be selected on the picture for viewing in the waveform or vector displays.

ORDERING INFORMATION

VM700 Video Measurement Set **$14,000**



DP-100 Digital Video Probe

NEW DP-100

Digital Video Probe

- **Convenient Analog Display of Digital Television Signals**
- **Fully Buffered ECL/TTL Probe**
- **Up to 100 MS/s Data Rates**
- **Precision 10-Bit DAC**
- **Switchable Reconstruction Filter**
- **Adjustable Clock Phasing**
- **Adjustable Sync Timing**

A Simple New Tool

The DP-100 Digital Video Probe is a simple, yet versatile, tool for evaluating digital television equipment. You can tap into a data bus, convert the signal to analog, and display it on any scope or waveform monitor, picture monitor or vectorscope.

TTL/ECL Compatible Probe

The DP-100 uses a fully buffered active logic probe to minimize loading of the circuit under test. This probe transfers data to the DP-100's DAC. A separate clock probe locks the DP-100 to your system clock.

Digital to Analog Converter

The DP-100 incorporates a 10-bit, 100 MS/s precision DAC for compatibility with a wide range of television equipment. The DAC's stepped analog output may be viewed directly or through a 5.5 MHz reconstruction filter. Sin X/X correction is optimized for 13.5 MS/s data rate.

System Clock

Propagation delays through signal processing circuitry pose no problem for the DP-100. With its front-panel adjustable clock phasing control, you can select the optimal timing to latch data into the DAC. The DP-100 clock processing operates from 1 to 100 MHz, and you can mix logic families to use an ECL clock with TTL data.

Sync

The DP-100 inserts a blanking reference level on the video output, making it compatible with clamping circuits in conventional picture monitors and waveform monitors. The DP-100 also provides a sync pulse output to drive these monitors.

You can preset sync timing, or use the front-panel sync timing controls for continuous cross-pulse displays.

ORDERING INFORMATION

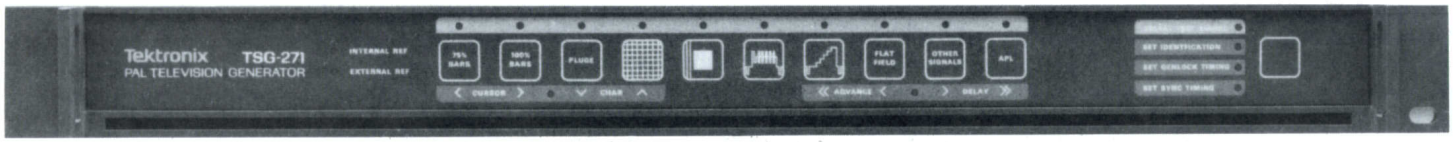
DP-100 Digital Video Probe **$2,965**
Includes: P6460 data probe; P6454 clock probe; instruction manual 070-6506-00.

OPTION

Option 01—Deletes the P6460 Data and P6454 Clock probes **−$965**

OPTIONAL ACCESSORY

TM 5000/TM 500 Mainframes—
See page 470.



TSG-271 PAL Television Generator

NEW TSG-271

PAL TV Generator

- **Precise 12-bit Digitally Derived Test Signals**
- **SCH Phase Accuracy, Guaranteed by Use of a Single DAC**
- **Conforms to EBU Statements D23 and D25**
- **Stable Internal Reference, Ideal for Master Sync Operation**
- **Reliable Slave Operation Through Use of Digital Genlock**
- **Separate Front-Panel Genlock and Sync Timing Controls**

Until now, your choices in PAL test signal generators were limited. Now, with Tek's TSG-271 PAL Television Generator, you can choose performance unmatched for the price. The TSG-271 features a unique digital architecture and innovative technology.

Test Signals

The TSG-271 uses digital signal generation and a precision 12-bit DAC to insure test signal accuracy and long term stability. Digital generation of the composite PAL signal, without analog modulators, allows use of a single DAC to inherently match chrominance and luminance timing. This insures accurate SCH phasing.

Sync Generator with Digital Genlock

The TSG-271 sync generator's stable color standard and unique digital genlock make it ideal for either master generator or slave operation. All outputs are correctly SCH phased, even if the TSG-271 is locked to an improperly SCH phased reference input. The digital genlock calculates sync timing and subcarrier phase to properly identify color framing of the reference signal. The TSG-271 automatically senses composite video reference input and, in the absence of a reference input signal, automatically switches to its own internal reference. With its constant temperature oven, this high stability crystal oscillator insures long term frequency stability.

ORDERING INFORMATION

TSG-271 PAL Television Generator **$4,500**

OPTION

Option 01—Adds character ID, Audio Tone, and Tape Leader Countdown **+$635**

SPG-170A NTSC Sync Generator.

SPG-170A NTSC Sync Generator

- **Digitally Generated RS-170A Black Burst**
- **Digital Genlock**
- **High-Stability Subcarrier**
- **Flexible Pulse Outputs**
- **Pulse Timing Independent of Black**
- **Remote Control Timing Presets**
- **Remote Control ID Presets**
- **SMPTE Bars, ID, and Audio Tone (Option 01)**

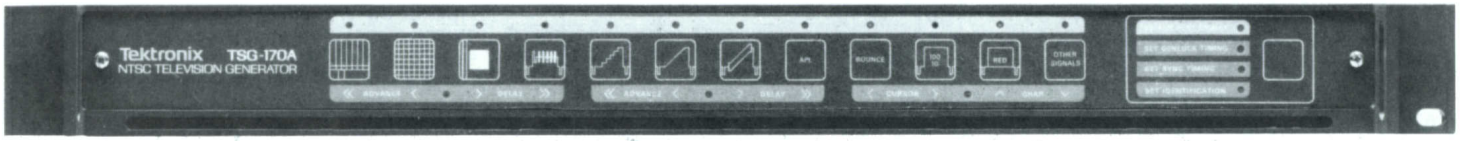
The SPG-170A sync generator offers all the features expected in a sync generator, plus the advantages of digital accuracy and system flexibility. Ideal for either master or slave generator operation, the SPG-170A features stable RS-170A performance and a rugged 1¾-inch package. The SPG-170A Option 01 provides even more versatility by adding SMPTE bars with programmable identification and audio tone.

ORDERING INFORMATION

SPG-170A NTSC Sync Generator **$3,300**

OPTION

Option 01—SMPTE Bars with ID and Audio Tone Output **+$1,000**



TSG-170A NTSC Television Generator.

TSG-170A
NTSC Television Generator

- **Simple, Effective Test Signal Complement**
- **RS-170A Sync Pulse Generator With Digital Genlock**
- **Separate Timing Controls for Sync and Test Signals**
- **Separate SMPTE Bars Output With Programmable ID (Option 01)**
- **Audio Tone Output (Option 01)**
- **Tape Leader Countdown**

The Tektronix TSG-170A NTSC Television Generator offers you the test signals you need plus the advantages of master and genlock sync capability. It provides true 10-bit digital signal accuracy with a full complement of test signals and a stable RS-170A sync generator.

The rugged, compact TSG-170A is designed to support both operational and maintenance requirements. The TSG-170A Option 01 provides even more versatility by adding a separate SMPTE bar generator, programmable identification, and audio tone output.

Features

- SMPTE Bars
- Convergence
- Pulse and Bar with Window
- Multiburst
- 5-Step Luminance Staircase
- Luminance Ramp
- Modulated Ramp
- Selectable 10% or 90% APL
- Bounce
- 10 and 100 IRE Flat Fields
- Red Field
- Multibars
- NTC7 Composite
- System Test Matrix
- Monitor Set-Up Matrix
- 5-MHz Line Sweep
- Multipulse
- DAC Calibration Signals

ORDERING INFORMATION

TSG-170A NTSC Television Generator **$4,995**

OPTION

Option 01—Adds separate SMPTE Bars output with 12 Character ID, Audio Tone Output and Tape Leader Countdown. **+$1,000**

ECO-170A Synchronous Changeover.

ECO-170A
Synchronous Changeover

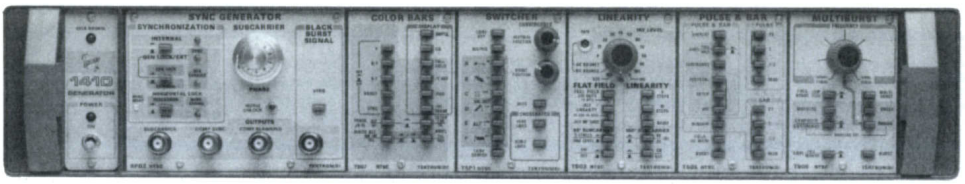
- **Automatic Sync Changeover**
- **Clean Electronic Switching**
- **Unique Fault-Detection System**
- **8 Channels**
- **Manual Override**
- **Remote Control With Fault Indicators**
- **NTSC/PAL Systems Compatibility**

The ECO-170A Synchronous Changeover provides transparent, automatic selection of sync sources. Front-panel controls allow simple access to changeover functions. A two-level front-panel lockout protects these controls in critical master sync systems.

ORDERING INFORMATION

ECO-170A Synchronous Changeover **$2,000**

See TSG-300 Component Television Generator on page 145.



1410R Option 04 Test Signal Generator.

1410R/1411R/1412R

NTSC, PAL, and PAL-M Generators

- **Five Test Signal Generators and One Switcher**
- **Conforms to EIA Standard RS-170A (1410R)**
- **700 mV White Level on Field 1, Line 7 (1411R)**
- **Sync to Subcarrier Phasing Maintained or Corrected**
- **Color Frame Reference Output**
- **Genlock to Composite Video**
- **Lock to External References**
- **Adjustable Blanking Widths**
- **Adjustable Sync Delays (H and V)**
- **Parallel Test Signal Outputs**

Three different models are available. The 1410R is for NTSC applications, the 1411R for PAL, and the 1412R for PAL-M applications.

ORDERING INFORMATION

1410R NTSC PACKAGES STANDARD CONFIGURATIONS

	Option 03	Option 04
TSG2 Convergence	x	
TSG3 Linearity	x	x
TSG5 Pulse and Bar		x
TSG6 Multiburst		x
TSG7 Color Bars	x	x
TSP1 Switcher		x

1410R NTSC Mainframe and SPG2A **$4,200**

OPTIONS

Option 03*1—NTSC Package Installed and Tested Together. **+$3,460**

Option 04*1—NTSC Package Installed and Tested Together. **+$8,280**

*1 *Cannot be combined with any other option.*

1411R PAL PACKAGES STANDARD CONFIGURATIONS

	Option 03	Option 04
TSG11 Color Bars	x	x
TSG12 Convergence	x	
TSG13 Linearity	x	x
TSG15 Pulse and Bars		x
TSG16 Multiburst		x
TSP11 Switcher		x

1411R PAL Mainframe and SPG12 **$4,200**

OPTIONS

Option 03*1—PAL Package Installed and Tested Together. **+$3,000**

Option 04*1—PAL Package Installed and Tested Together. **+$7,500**

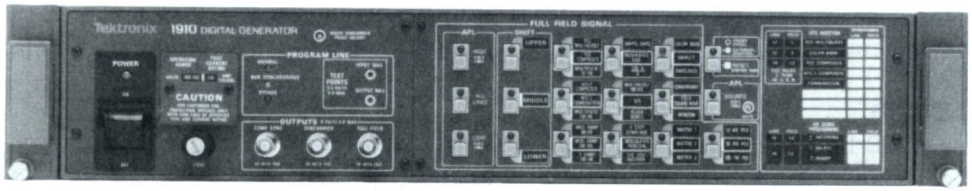
*1 *Cannot be combined with any other option.*

PAL-M PACKAGES

1412R PAL-M Mainframe and SPG22, TSG21 **$7,415**

Option 05—Adds TSG23/TSG25/TSG26/TSP21 Installed. **+$8,795**

For complete Television Product information, request the Television Products catalog.



1910 NTSC Digital Generator/Inserter.

1910 Digital Generator

- **Four External VITS Inputs for Insertion of Teletext, Closed Captioning, Source ID, etc.**
- **Nonvolatile Memory to Maintain Selected VITS and Full Field Signal Configuration After Power Interruption**
- **Signal Stored in Replaceable EPROM so Your 1910 Won't Become Obsolete**
- **The Accuracy and Stability of an All-Digital 10-Bit Sync and Signal Generator (RS-170A)**
- **User-Friendly RS-232C Control Port for Added Versatility**
- **New Signals (Eye Test Pattern, Special Multipulse, Color Multipulse), New Functions (VITS Sequence, Field Sequence and More)**

The 1910 Digital Generator is a state-of-the-art test signal generator designed for performance testing of NTSC video systems and equipment. The 1910 is especially suited where high accuracy and stability are required. It is also a VITS inserter (internal and external) with a full complement of signals that allow testing in studio, transmitter, production, or research environments. Four external VITS inputs permit insertion of signals such as teletext, closed captioning, source ID, and other similar sources. These four inputs may be converted to four pulse outputs for use in a production environment.

External interfacing of the 1910 is controlled by an internal microprocessor and its nonvolatile memory. Test signals are stored as 10-bit digital words and converted to analog form by a 10-bit precision DAC (with deglitching to reduce differential gain and differential phase) to ensure signal accuracy as well as long term stability and repeatability.

Since all signals are stored in replaceable EPROMs, changing needs and industry standards will not cause obsolescence.

Control and versatility of the 1910 are greatly enhanced by the use of its RS-232 control port. Most functions of the 1910 can be controlled, reconfigured and saved, including VITS and full field signal selection, matrix signal creation, sequences, and other features.

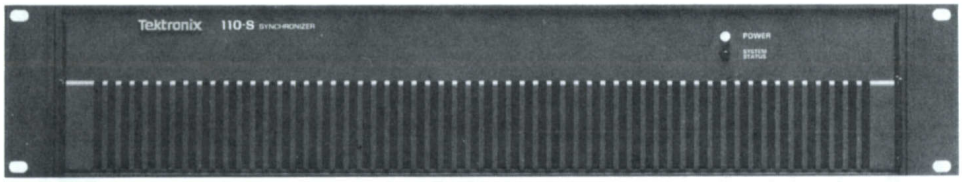
ORDERING INFORMATION

1910 Digital Generator **$9,990**

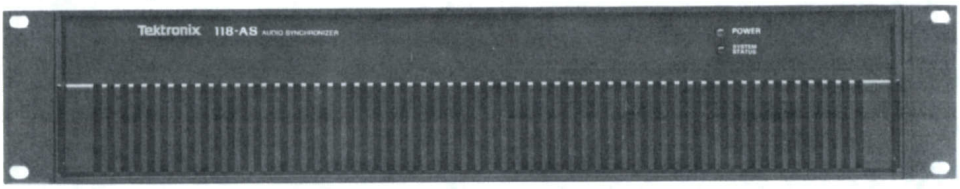
OPTION

Option 03—CBC Test Signals. **NC**

For complete Television Product information, request the Television Products Catalog.



110-S Video Synchronizer.



118-AS Audio Synchronizer

110-S Video Synchronizer/TBC

- **True 10-Bit Accuracy and Resolution**
- **Tracks Signals into the Noise**
- **Optional Four-Field Memory for the Highest Picture Quality**
- **Adaptive Decoding—Minimizes Picture Shifts While Preserving Horizontal and Vertical Detail, Provides Exceptionally High-Quality Picture Freeze**
- **Adaptive Clamping—Minimizes Streaking on Noisy Signals**
- **Digitally Precise RS-170A Sync and Burst Insertion**
- **Passes the Vertical Interval**
- **Processing Amplifier**
- **Precalibrated Boards in Modular Design**
- **Heterodyne Color Processing**
- **Auto VTR Signal Recognition**
- **Infinite Window Correction Range**

The 110-S is a high-quality, 10-bit, 4X fsc video synchronizer. The 10 bit architecture, adaptive decoding, and adaptive clamping combine to provide a synchronizer that performs well on noisy signals, minimizes horizontal picture shifts, and is virtually transparent to the processed signal.

10-Bit Precision

A Tektronix-designed 10-bit digitizer and a sampling rate of four times the subcarrier frequency result in negligible quantizing errors, low differential gain and phase, and a flat frequency response. Compared to 8-bit synchronizers, the 110-S has four times the accuracy and resolution. The resulting transparency to the video signal allows cascading of 110-S synchronizers in the signal path with minimum signal degradation.

Tracking Into Noise

When noise from a fading ENG microwave feed or static interference degrades the S/N ratio, the 110-S will continue to track the signal. If the original sync and burst are clean, they may be passed with the original signal. Noisy sync and burst are replaced with precise, digitally generated RS-170A sync and burst. The 110-S can be configured to track into the noise, freeze field, or go to black upon loss of the incoming signal. As noise increases, an adaptive clamp slows down to prevent horizontal streaking while still responding quickly to hot switches.

The 110-S TBC option adds time-base correction for heterodyne color VTRs to the 110-S Synchronizer.

ORDERING INFORMATION

110-S Video Synchronizer	$14,975
OPTIONS	
Option 10—Four-Field Memory Adaptive Decoder.	+$1,500
Option 20—Adds time-base correction for heterodyne color VTRs	+$2,000
110-RC Remote Control Unit	$500

For complete Television Product information, request the Television Products Catalog.

118-AS Audio Synchronizer

- **Automatic or Manual Control of Audio to Video Timing**
- **Simple One-Wire Interface to 110-S Video Synchronizer**
- **Expandable to Three Channels for Stereo and Auxiliary Channel**
- **Compensates for up to Ten Fields of Video Delay**
  93.75-kHz Sampling Provides Accurate Stereo Phasing and Flat Frequency Response
  18-Bit Floating-Point Code for Wide Dynamic Range
- **Built-In Diagnostics and Easy Module Access for Service**

The Tektronix 118-AS Audio Synchronizer provides automatic and/or manual control of audio delay to maintain proper audio to video timing. With 18-bit floating point code and 93.75 kHz sampling, the Tektronix 118-AS brings to audio synchronization the same high standards established for video synchronization by the Tektronix 110-S.

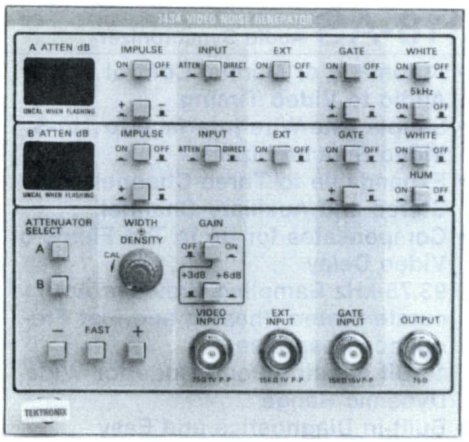
The 118-AS Audio Synchronizer automatically tracks the 110-S Video Synchronizer using a simple one-wire digital interface. The 118-F02 video interface board allows the 118-AS to automatically track the delay of other video equipment. Additional fixed audio delay may be added manually to compensate for audio to video timing errors present on an incoming signal.

The standard 118-AS is a single-channel audio synchronizer, which may be expanded to two or three channels for stereo or second-language applications.

ORDERING INFORMATION

118-AS Single-Channel Audio Synchronizer with 118-F02 Video Interface	$5,500
118-F01 Audio Channel Kit (adds one channel)	$1,000
118-F02 Video Interface Kit	$1,400
118-RC Remote Control Unit	$850

For complete Television Product information, request the Television Products Catalog.



1434 Video Noise Generator

1434 Video Noise Generator

- **Calibrated Noise Levels**
- **White Noise**
- **Impulse Noise With Selectable Polarity, and Variable Width and Density**
- **Hum—50 Hz or 60 Hz**
- **5-kHz Sine Wave**
- **Noise Gating**
- **Calibrated Video Gain and Attenuation**
- **Works With NTSC, PAL, PAL-M, and SECAM**

ORDERING INFORMATION

1434 Video Noise Generator **$5,500**

1430 Random Noise Measuring Set

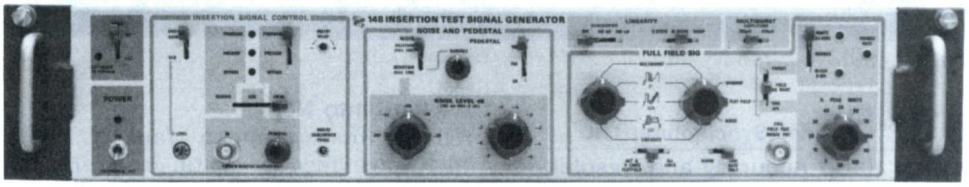
- **Conforms to CCIR Recommendation 568**
- **In-Service Testing**
- **Out-of-Service Testing**
- **Program Material Protected by Fail-Safe Provisions**
- **525/60 or 625/50 Standards**

ORDERING INFORMATION

1430 Random Noise Measuring Set (525/60) **$4,115**
Option 01—Random Noise Measuring Set (625/50) **+$85**

1430 Random Noise Measuring Set

1440 Automatic Video Corrector



Test Signal Generators

1440 Automatic Video Corrector

- **Maintains Consistent High-Quality Color Pictures**
- **Automates Transmitter Modulation Level Control**
- **Maintains Correct Sync-To-Video Ratios During Line-Voltage Fluctuations**
- **Automatic VIRS Referenced Correction of:**
  Overall Video Signal Amplitude, Chrominance to Luminance Gain Ratio, Black Level, Chrominance Phase, Burst Gain, Sync Gain

ORDERING INFORMATION

1440 NTSC Automatic Video Corrector **$6,325**

OPTIONAL ACCESSORIES

Remote Control Unit for 1440—
Includes two connectors.
Order 015-0240-00 **$1,020**

Remote Monitor Unit for 1440—
Includes one connector.
Order 015-0239-00 **$1,080**

Six Foot Extender Cable—With connectors for use between the 1440 and Remote Control Unit or Remote Monitor Unit.
Order 012-0131-00 **$405**

Three Foot Extender Cable—
With connectors for use between the 1440 chassis and the rear rackmounting section.
Order 012-0637-00 **$410**

For complete Television Product Information, request the Television Products Catalog.

[1] Contact your local sales office.

R148/R148-M

Test Signal Generators

- **Insertion Test Signals (EBU, CCIR Recommendation 473-2, Annex 1)**
- **Full-Field Test Signals (CCIR Recommendation 567)**
- **Easily Reprogrammable**
- **Safe In-Service ITS Insertion (EBU Specifications)**
- **Noise Measurement**
- **APL Bounce Signal**
- **Source Identification Code**
- **Operates With Sound In Syncs**
- **Locks With Mixed Sync (EBU Homologation Specifications for ITS Generators) Subcarrier, PAL Pulse, Burst Flag, Comp Sync**

ORDERING INFORMATION

R148 PAL Test Signal Generator **$5,540**
R148-M PAL-M Test Signal Generator **$8,700**

OPTIONAL ACCESSORIES

External filters are required with the 148 Generator when making noise measurements.

Low Pass 6.0 MHz 625/50—
Order 015-0220-00 **$130**

Noise Weighting 5.0 MHz 625/50—
Order 015-0215-00. **$100**

Low Pass 4.2 MHz 525/60—
Order 015-0212-00 **$155**

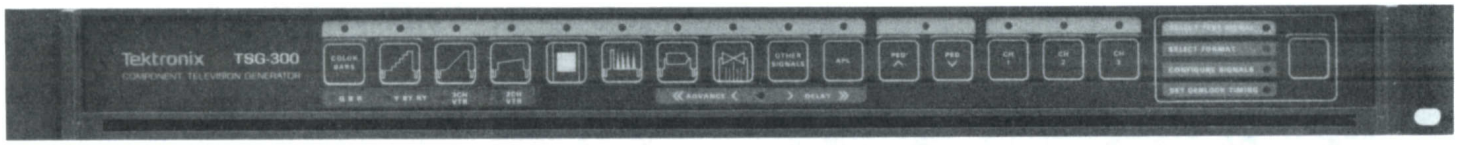
Noise Weighting 4.2 MHz 525/60—
Order 015-0214-00 **$100**

CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

Low Pass 5.0 MHz—
Order 015-0213-00 **$150**

Unified Noise Weighting Network—
Order 015-0283-00 **$85**

Rackmount to Cabinet Conversion Kit—Order 040-0573-00*[1]



TSG-300 Component Television Generator.

TSG-300

Component Television Generator

- **Multiple Formats and Standards: Y,B-Y, R-Y (Y,P_b,P_r; SMPTE/EBU); GBR; Betacam®; MII; 525/60 and 625/50**
- **10-Bit Digital Signal Generation**
- **New Test Signals for Component Video: Bowtie; Coring; Valid Ramp; Shallow ramp**
- **User Configurable Controls**
- **Digital Genlock**

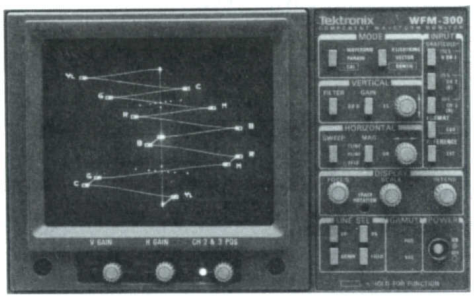
From news gathering to post-production, component television is providing new levels of image quality and operational flexibility. While component television solves many problems inherent in composite NTSC and PAL, it brings with it a new set of concerns. The TSG-300 Component Television Generator provides innovative solutions to the measurement problems encountered in component television systems.

ORDERING INFORMATION

TSG-300 Component Television Generator **$8,850**

See 650HR-C Series Component/Composite Picture Monitors on page 154.

For complete Television product information, request the Television Products Catalog.



WFM-300 Component Television Waveform Monitor with Vector Display.

WFM-300

Component Television Waveform Monitor

- **Lightning Display**
- **Parade and Waveform Overlay Display**
- **Vector Display**
- **Bowtie Timing Display**
- **Color-Gamut Limit Indication**
- **Linearity Measurements**
- **Y,P_b,P_r; Y,B-Y,R-Y; G,B,R; Y,Q,I Input Options**
- **Electronic Graticule**
- **625/50 and 525/60 Selectable**
- **GBR Picture Monitor Output**

The versatile WFM-300 Component Television Waveform Monitor provides a comprehensive set of signal monitoring capabilities designed specifically for the component television environment. New component-based television equipment produces signals quite different from the composite television signals, and the WFM-300 provides new monitoring capabilities to meet this challenge. An innovative new Lightning display provides amplitude and timing information for all three channels simultaneously, allowing the operator to set up equipment accurately and efficiently. The traditional parade display of three signals provides side-by-side comparison of all signals. In addition, any combination of the three signals can be overlaid for accurate comparisons. Both horizontal and vertical magnification can be applied for detailed inspection of the signal being observed.

A vector display of the color difference signals provides the traditional color-bar vector display. The Bow-tie timing test signal from the TSG-300 component television test signal generator allows precise timing of three-wire component television systems. This signal utilizes a channel 1 minus channel 2 and 3 mode to provide a side-by-side differential comparison (1-2, 1-3) of all three channels.

The WFM-300 has full-frame line select, with alphanumeric readout. Any one or two lines of the entire frame can be selected and displayed, or the same line(s) in both fields can be viewed at one time. An intensified zone in the two-field sweep indicates the location of the line selection. In addition, any successive 15 lines can be overlaid.

The input signal can be color difference or GBR, with optional accommodation for several color difference formats. All of these signal types are converted to GBR for a dedicated picture monitor output. The valid GBR gamut limit is monitored to make sure the operator is warned if a combination of signals is not valid. The WFM-300 can be configured for either 525/60 and 625/50 signal standards.

ORDERING INFORMATION

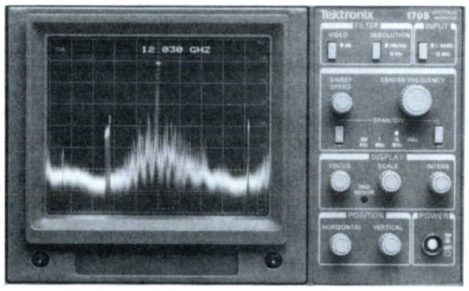
These instruments are configured for rack-mounting and are shipped without cases or covers. Order appropriate optional accessories on next page to configure for rack, bench, or portable use. The WFM-300 is a UL recognized component and meets the requirements for listing when used in the appropriate enclosure.

WFM-300 Component Television Waveform Monitor (525/60 operation) **$4,900**

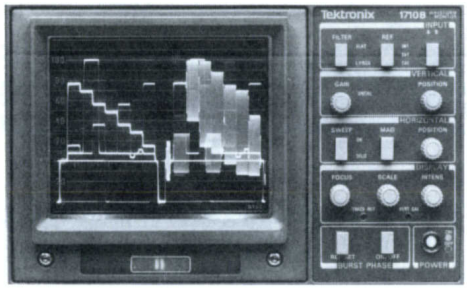
OPTIONS

Option 01—For 625/50 operation. **NC**
Option 10—For Betacam transcoder. **+ $120**
Option 12—For YQI transcoder. **+ $120**
Option 14—for MII transcoder. **+ $120**

See 650HR-C Series Component/Composite Picture Monitors on page 154.



1705 Spectrum Monitor



1710B Waveform Monitor—Dual Filter Display

NEW 1705 Spectrum Monitor

- **Designed for Satellite News Gathering**
- **Easy, Reliable Operation**
- **Cost Effective**
- **On-Screen Frequency Readout**
- **On-Screen Setup Menu**
- **L-band and 70 MHz IF Inputs**
- **Resolution Switchable to 10 or 300 kHz**
- **Span Range and Video Filter Selection**
- **Center Frequency Control**
- **Bright Clear Display**
- **DC Operation Available**

The Tektronix 1705 Spectrum Monitor is a special purpose radio frequency monitor designed for rapid response television satellite news gathering applications. Using the 1705, an operator can identify the spectral pattern of a particular satellite and transponder to determine which video, audio, and SCPC carriers are present. It assists in the accurate adjustment of azimuth, elevation and polarization of the downlink/uplink antenna. It also provides a display of satellite and locally generated signals.

Dual Band Operation

The 1705 features front panel selectable inputs for L-band (900-1450 MHz) monitoring of television downlink signals from a low noise block converter (LNB) located at receive antenna, and 70 MHz band (45-100 MHz) monitoring of the television uplink exciter or other IF signals. Input frequency is displayed on-screen in both L-band and 70 MHz modes, and the L-band readout may be reconfigured to display a satellite frequency in the range of 0.9-20.0 GHz. A dc output is provided to power the low noise block converter.

1710B Series Waveform Monitors

- **Cost Effective**
- **Easy Operation**
- **Burst Phase Indicator**
- **Dual-Filter Display**
- **Half-Rack Width**
- **Bright CRT Display**
- **Internal Graticule**
- **Light Weight**
- **Low Power Consumption**
- **Portable DC Power and Battery Available**
- **Available in NTSC and PAL Standards**

The 1710B Series waveform monitors provide all of the commonly used display modes. In addition, the 1710B Series adds relative burst phase indication and dual-filter display. All this capability in a cost-effective package for the user who wants high quality at a low price. These monitors are mechanically compatible and retrofit into an existing system that uses half-rack width, 5½-inch waveform monitors.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	133	5.2
Height	214	8.4
Depth	429	16.9
Weight ≈	**kg**	**lb**
Net	3.6	8.0

ORDERING INFORMATION

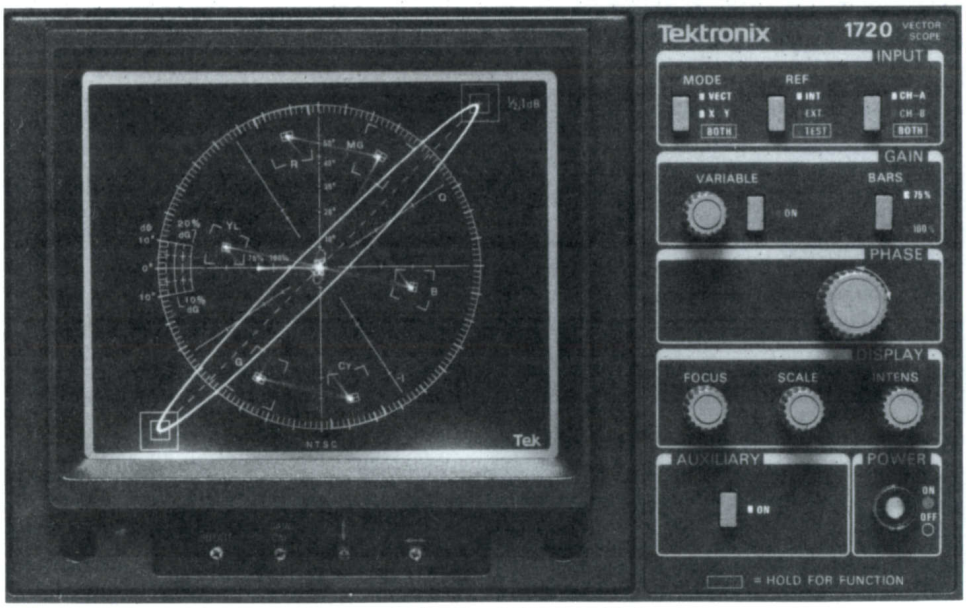
These instruments are configured for rack mounting and are shipped without cases or covers. Order appropriate optional accessories to configure for rack, bench or portable use.

1705 Spectrum Monitor	$3,850
1700F10 DC Power Converter Kit	$200
1700F02 Portable Cabinet and BP1 Battery Pack	$85
1710B Waveform Monitor (NTSC System Applications)	$1,745
1711B Waveform Monitor (PAL System Applications)	$1,745

OPTIONAL ACCESSORIES

Cabinets—	
(Plain) Order 1700F00	$60
(Portable) Order 1700F02	$85
Side-By-Side Rack Mount—For mounting two half-rack instruments in a standard 19-inch rack. Order 1700F05	$180
Blank Panel Adapter—For the side-by-side rack mount. Order 1700F06	$60
Viewing Hood—For high ambient light environments. Order 016-0475-00	$10
Cameras—	
(Regular) C-5C Option 02.	$465
(Automatic) C-7 Option 03.	$565
Battery Pack—Requires 1700F02 case, 1700F10 dc operation kit, and battery charger. Order BP1	$600
DC Operation Kit—12 V dc. Order 1700F10	$200

For complete Television Product information, request the Television Products Catalog.



1720 Vectorscope—Vector and Stereo Audio Dual Display Mode.

1720/1730

- **Performance and Economy**
- **Complete Line Select**
- **Simultaneous Channel A and B Display**
- **Dual-Filter Display**
- **One-Button Front-Panel Recall**
- **Differential Phase and Gain Measurement**
- **Stereo Audio Phase Measurement**
- **RGB/YRGB Display Capability**
- **Vector Center-Dot Clamping**
- **Parallax-Free Internal Graticules**
- **Portable DC Power and Battery Available**
- **Remote Control Capability**
- **Available in NTSC, PAL, Dual PAL/ NTSC, and PAL-M Standards**

The 1730 Series Waveform Monitors and 1720 Series Vectorscopes provide a new dimension in television signal monitoring for both NTSC and PAL applications. These versatile instruments are lightweight, half-rack width, and have bright CRTs for comprehensive video signal monitoring. Both instruments exceed normal monitoring capabilities. Their unique features make them even more powerful when operated in tandem. Each monitor has its own advanced feature set and the proven 1700 Series family performance to provide more monitor for the money. These monitors do the job faster, better, and easier at a low price.

Complete Line Select

The 1730 Series Waveform Monitor has full-frame line select, with alphanumeric readout, that can be tracked by the 1720 Series Vectorscope when in Auxiliary mode. Any one or two lines of the entire frame can be selected and displayed, or the same line(s) in both fields can be viewed at one time. An intensified zone in the two-field sweep and on the picture-monitor output signal indicates the location of the line selection. In addition, any successive 15 lines can be overlaid for camera and VTR adjustments.

Simultaneous Channel A and B Display

These instruments have state-of-the-art microprocessor front-panel control. They are operator-friendly and provide features in half-rack waveform monitors or vectorscopes. Both the 1730 Series Waveform Monitor and the 1720 Series Vectorscope have dual-channel display capability, allowing both input channels to be displayed on the CRT simultaneously.

Dual-Filter Display

The 1730 (NTSC) and the 1731 (PAL) Waveform Monitors include dual filter display, which provides low-pass and flat information in the same display. The 2-Field and 2-Line Display Modes have the Low-Pass Filter applied to the left half of the trace. In the 1-Line Mode, the two signals are overlaid. These filter modes can also be used independently. Both versions of the 1730 Series have chroma filters centered around the subcarrier frequency.

One-Button Front-Panel Recall

Once the front panel has been set up in a frequently used mode, the configuration can be stored for later one-button recall. In addition, when the 1720 is used in tandem with the 1730, it will respond to this Store/Recall operation. Up to four operator-selected front-panel configurations can be stored from the front panel. Four other front-panel configurations are factory-programmed settings and are accessible from the Remote Control interface.

Differential Phase and Gain Measurements

The 1720 Series Vectorscope graticule has scales for measuring Differential Phase and Gain. The Differential Phase scale has markings at 2° intervals. The Differential Gain scale has markings at 5% intervals. For even greater precision, the 1720 and 1730 Series can be coupled for using the field or line sweep on the 1730 Series Waveform Monitor. The Waveform Chroma filter can be used for differential gain measurements.

Stereo Audio Phase Measurements

Balanced inputs for the X-Y mode are available on the 1720 Series Vectorscope through a separate input connector. This mode is particularly useful for evaluation of stereo audio using a special X-Y graticule scale for both amplitude and phase measurements. X-Y measurements can be displayed individually or in combination with a vector display. This input can also be used for other applications where X-Y monitoring is useful.

RGB-YRGB

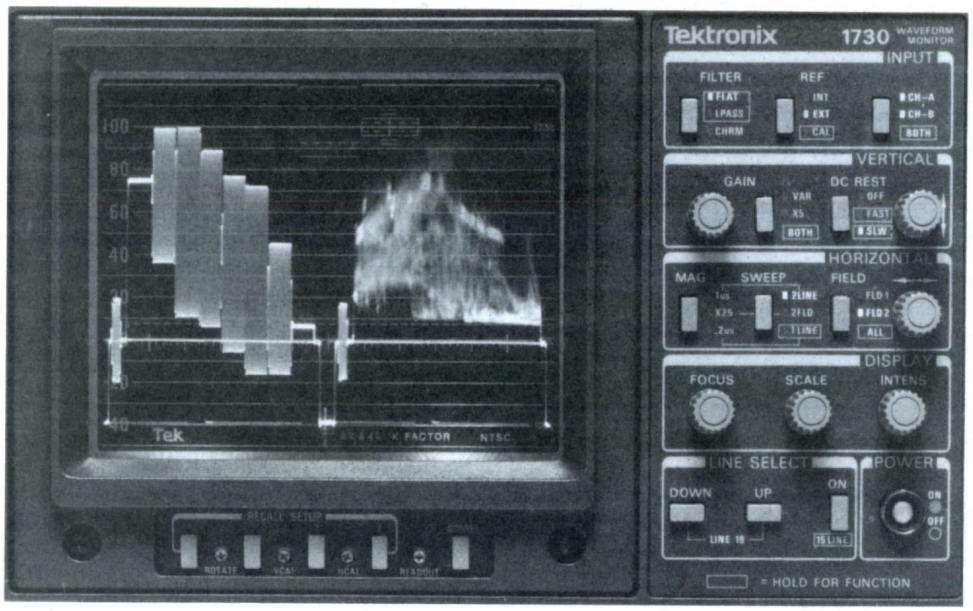
The Waveform Monitor can display RGB or YRGB staircase. The RGB/YRGB staircase input is through a rear-panel connector.

Vector Center-Dot Clamping

These vectorscopes employ center-dot clamping in Vector mode for easy detection of residual subcarrier on the signal. In addition, with no signal present, the center dot automatically dims, prolonging the CRT life.

Parallax-Free Internal Graticules

Both instruments utilize post-accelerated, mesh-type CRTs equipped with internal graticules to provide parallax-free displays. Variable, evenly illuminated scales, along with molded bezels, make waveform photography simple.



1730 Waveform Monitor—Simultaneous Channel A and B Display.

Portable DC Power

In addition to being ideal for camera control units and video tape recorders, these instruments can be equipped with cabinet and field upgrades allowing them to operate from a 12 V dc source for portable operation. They can be used with the Tektronix BP1 or other 12 V supply. Coupling this dc operation with their light weight (about 9 pounds, including cabinet), low power consumption, and compact size makes these instruments well suited for use on a portable production cart.

Remote Control

Internal front-panel presets, RGB/YRGB enable, along with front-panel recall/setup can be accessed through the Waveform Monitor Remote connector.

Available in NTSC, PAL, and PAL-M

Both the 1730 Series and the 1720 Series are available in either NTSC or PAL versions. The 1721 Vectorscope and the 1731 Waveform Monitor are the PAL versions.

The 1735 Waveform Monitor provides PAL/NTSC Dual Standard Monitoring. PAL-M instruments are available as a modified product.

A modified version of the 1730 Waveform Monitor is available for high definition television applications.

ORDERING INFORMATION

These instruments are configured for rack mounting and are shipped without cases or covers. Order appropriate optional accessories to configure for rack, bench, or portable use. The 1720, 1721, 1730, 1731, and 1735 are UL-recognized components and meet the requirements for listing when used in the appropriate enclosure.

1720 Vectorscope
(NTSC System Applications) **$2,250**

1721 Vectorscope
(PAL System Applications) **$2,250**

1730 Waveform Monitor
(NTSC System Applications) **$2,250**

1731 Waveform Monitor
(PAL System Applications) **$2,250**

1735 Waveform Monitor
(PAL/NTSC Dual Standard Applications) **$2,450**

PAL-M instruments are available as a modified product.

Portable DC Powered Applications 17XX (from above) plus 1700F10 DC Power Converter Kit, 1700F02 Portable Cabinet and BP1 Battery Pack. Battery charger not included.

OPTIONAL ACCESSORIES

Cabinets—
(Plain) Order 1700F00 **$60**
(Portable) Order 1700F02 **$85**

Side-By-Side Rack Mount—For mounting two half-rack instruments in a standard 19-inch rack.
Order 1700F05 **$180**

Blank Panel Adapter—For the side-by-side rack mount.
Order 1700F06 **$60**

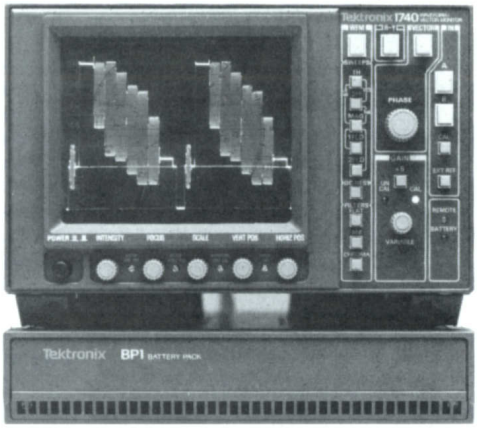
Viewing Hood—For high ambient light environments.
Order 016-0475-00 **$10**

Cameras—
(Regular) C-5C Option 02. **$465**
(Automatic) C-7 Option 03. **$565**

Battery Pack—Requires 1700F02 case, 1700F10 dc operation kit and battery charger. Order BP1 **$600**

DC Operation Kit—12 V dc.
Order 1700F10 **$200**

For complete Television Product information, request the Television Products Catalog.



1740 Waveform/Vector Monitors with optional carrying case and battery pack.

1740 Series Waveform/Vector Monitors

- **Two Instruments in One**
- **Optional DC Power Capability**
- **Bright CRT Display**
- **R-Y (V Axis) Mode**
- **VITS Monitoring**
- **RGB/YRGB Display Capability**
- **Remote Control Capability**
- **Available in NTSC, PAL, and PAL-M**

The 1740 Series provides all the basic waveform monitoring and vectorscope functions in a single, compact package. In addition, the 1740 Series adds dc power operation (optionally), single-line vertical interval display which is internally preset, an R-Y sweep mode for differential phase measurements, and remote control of waveform/vector mode and most of the front-panel sweep and vertical-amplifier response functions.

The 1740-Series monitors are half-rack width. They are intended for use where space, power consumption and/or portability are prime considerations and where simultaneous waveform and vector displays are not required.

Typical applications include video signal monitoring in VTR bridges, camera control units, production switcher consoles, and in field production units.

ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without case or handles. Order appropriate options or optional accessories to configure for bench or portable use. **Option 06 is recommended.**

1740 Option 01 Waveform/Vector Monitor (NTSC Applications) **$3,970**

1741 Option 01 Waveform/Vector Monitor (PAL Applications) **$3,970**

1742 Option 01 Waveform/Vector Monitor (PAL-M Applications) **$4,370**

OPTIONS

Option 06—Composite internal graticule, waveform and vector. **+$30**

Option 07—Adds dc power operation capability, must be installed during manufacture. **+$60**

Option 11—Portable carrying case, dc power operation, and a BP1 Battery Pack. Battery charger not included. **+$650**

OPTIONAL ACCESSORIES

Cabinets—
(Plain) Order 1700F00 **$60**
(Portable) Order 1700F02 **$85**

Side-by-Side Rack Adapter—For mounting two half-rack instruments in a standard 19 inch rack.
Order 1700F05 **$180**

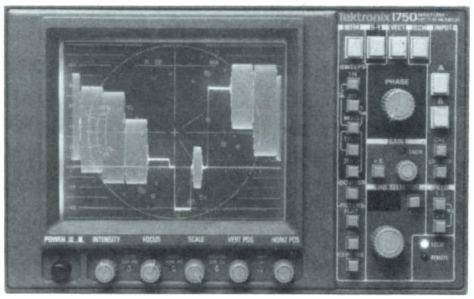
Blank Panel Adapter—For one half of the side-by-side rackmount.
Order 1700F06 **$60**

Viewing Hood—For high ambient light environments.
Order 016-0475-00 **$10**

Cameras—C-5C Option 02 **$465**
or standard C-4 **$375**

Battery Pack—Order BP1 **$600**

For complete Television product information, request the Television Products Catalog.



1750 Waveform/Vector Monitor—Dual Filter/ Simultaneous Display.

1750 Series Waveform/Vector Monitors

- **SCH Phase Monitoring and Measurement**
- **R-Y (V Axis) Mode**
- **RGB/YRGB Mode**
- **Remote Control Capability**

The 1750 Series offers comprehensive monitoring and measurement of television signals, including SCH phase and color framing, in one compact unit. While similar in appearance to other 1700 Series instruments, the 1750 has enhanced performance in each of its operating modes.

The unique SCH phase display presents horizontal sync timing relative to reference subcarrier (burst) for verification of signal format and color framing. This mode enables easy analysis and monitoring of these important characteristics of the television signal; a task which previously required complex techniques, highly skilled operators, and/or additional instrumentation. The 1750's SCH phase and color frame displays are derived from the standard composite signals. No extra pulses or added signal details are required.

The 1750's SCH capability makes it particularly valuable in production and editing environments where maintenance of SCH phase and color frame are critical considerations. Applications include VTR bridges, camera control units, switcher consoles, master control, mobile and field production units, and maintenance operations supporting any of these areas.

The 1750's half-rack package allows easy installation in environments where space and power requirements are important considerations. The 1750 is mechanically compatible with other 1700 Series Tektronix instruments.

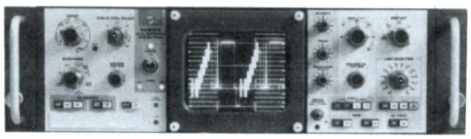
ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate optional accessories above to configure for rack, bench or portable use.

1750 Waveform/Vector Monitor (NTSC Applications) **$6,050**

1751 Waveform/Vector Monitor (PAL Applications) **$6,050**

For complete Television product information, request the Television Products Catalog.



1485R Option 01 PAL/NTSC Dual Standard Waveform Monitor (Rackmount).

1480 Series Waveform Monitors

- **Bright CRT Especially Suitable for Vertical Interval Testing**
- **Advanced Measurement Modes**
- **Amplitude Measurement Accuracy Approaching 0.2%**
- **Digital Selection of Line and Field**
- **Probe Input Option**
- **15-Line Display for VTR Applications**

Full feature capability for demanding video measurements in a range of applications

The 1480 Series was designed to meet the monitoring needs of CCU, VTR, control room, transmission facilities, transmitter and special systems with optimum accuracy, precision and performance. It features a variety of advanced measurement modes, amplitude measurement accuracy approaching 0.2%, and an exceptionally bright CRT that's especially suitable for vertical interval testing. . . bright enough for one vertical interval test signal selected out of four fields to be seen with ease even in a well lit area.

Digital selection of line and field assures positive identification of displayed information.

In addition to a 0.2% amplitude standard, the 1480 Series provides superior resolving power through calibrated five-times expansion of the vertical display, plus offset comparison and fine CRT spot size for making highly accurate amplitude measurements.

A unique overlay mode makes it possible to superimpose portions of waveform displays for exact, side-by-side comparison of levels.

A noise measurement kit is available for factory or field installation in rack mounting instruments only.

Among many additional features are a probe input option, AFC sweep synchronization, selectable filters, and 15-line display for VTR applications.

The 1480 Series is available in NTSC, PAL, PAL-M and NTSC/PAL Dual Standard versions.

Side by side (1480C) or rackmounting (1480R) configurations are available.

PHYSICAL CHARACTERISTICS

	1480C		1480R	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	216	8.5	482	19.0
Height	210	8.3	133	5.3
Depth	430	16.9	457	18.0
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	9.8	21.5	11.2	24.6
Shipping	24.1	53.1	24.1	53.1

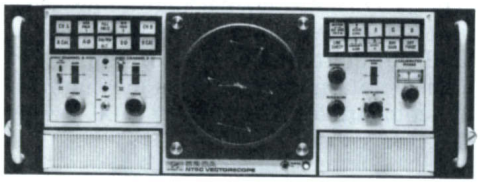
ORDERING INFORMATION

1480C NTSC Waveform Monitor	**$6,300**
1480R NTSC Waveform Monitor	**$6,300**
1481C PAL Waveform Monitor*1	**$6,300**
1481R PAL Waveform Monitor*1	**$6,300**
1482R PAL-M Waveform Monitor	**$6,790**
1485C PAL/NTSC Dual Standard Waveform Monitor*1	**$6,500**
1485R PAL/NTSC Dual Standard Waveform Monitor*1	**$6,500**

OPTIONS

Option 01—1 MΩ, 20 pF Probe Input (not available with Option 06, probe not included). Suggested Probe: P6108A 10X, 2 m Probe; or 3 m Opt.03	**+$300**
Option 06—(1480R only) 124 Ω WECO Style Inputs.	**+$2,075**
Option 07—Slow Sweep*2 (Option 07 performance included with Option 06. Do not order with Option 06).	**+$510**
Option 08—(1481C, 1481R, 1485C and 1485R only) SECAM Field Identification.	**+$315**
1480F30 Noise Measurement Kit 1480R, 1481R, 1482R, 1485R only.	**$600**

*1 *1481C/R, 1485C/R meets European Broadcast Union Tech. 3221-E, Guiding Principles for design of Television Waveform Monitors.*
*2 *Option 07 satisfies EBA Tech 3321-E § 3.2.2.*



R520A NTSC Vectorscope.

R520A Series Vectorscopes

- **Luminance Amplitude**
- **Chrominance Amplitude and Phase**
- **Precision Differential Gain and Phase**

Outstanding accuracy and versatility in a video measurement vectorscope

The 520A Series offers advanced capability that enables measurements of the chrominance signal and distortions thereof to be made with a high degree of precision. It effectively complements the 1480 Series in applications requiring highly accurate measurements of luminance amplitude, chrominance amplitude and phase, differential gain, differential phase, and other distortions.

The 520A Series provides polar coordinate displays with which to easily detect errors in color encoding, videotape recording and playback, or transmission processes that interfere with phase and/or amplitude relationships and lead to color errors in a television picture. Large phase shifts can be read from the parallax-free vector graticule, and a precision calibrated phase shifter is provided for measuring small phase shifts.

Differential gain and differential phase measurements can be made with accuracy to better than 1% or 1°. Using a trace overlay provides excellent resolution for measuring very small phase errors.

Other features include a voltage step-up termination option, VITS observation from front panel selected lines and dual vector display.

The 520A Series is available in NTSC, PAL and PAL-M versions.

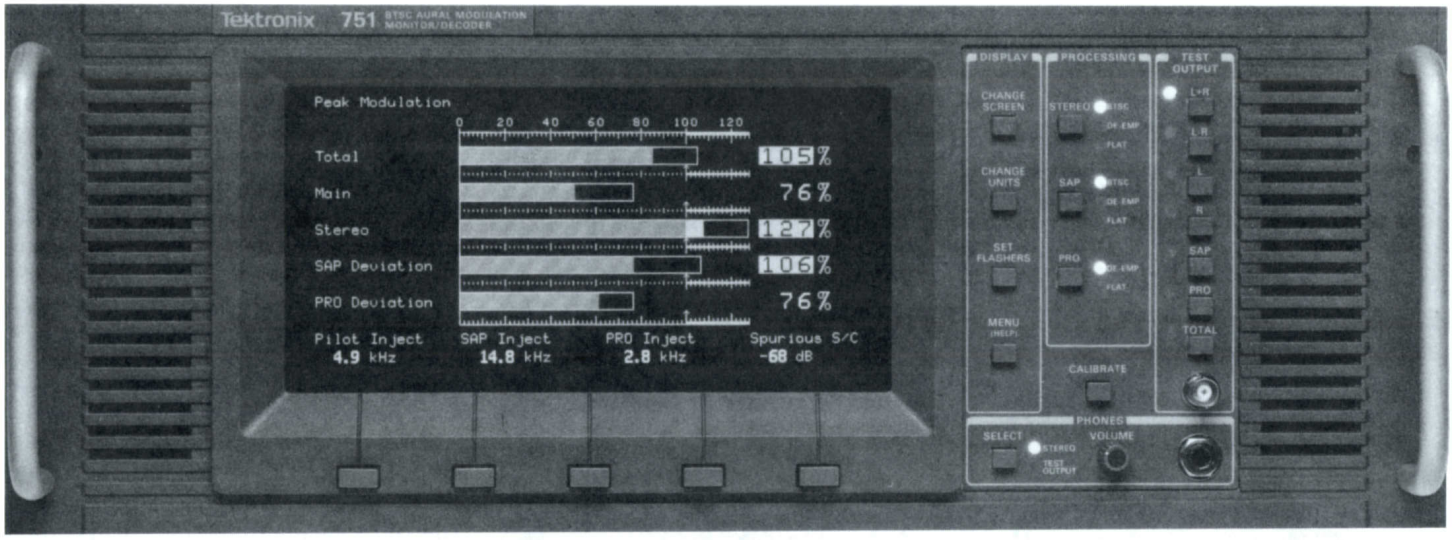
PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in.**
Width	483	19.0
Height	178	7.0
Depth	483	19.8
Weight ≈	**kg**	**lb**
Net	15.0	33.0
Shipping	27.7	61.0

ORDERING INFORMATION

R520A NTSC Vectorscope	**$8,525**
R521A PAL Vectorscope	**$8,525**
R522A PAL-M Vectorscope	**$9,540**

For complete Television product information, request the Television Products Catalog.



751 BTSC Aural Modulation Monitor/Decoder.

751

BTSC Aural Modulation Monitor/Decoder

- **Precision Modulation Monitor for Entire BTSC Sound Channel**
- **Simultaneously Displays All Components Necessary to Assure Modulation Remains Within Legal Limits**
- **Bars Feature Peak Indicators With Timed Peak Hold and Easily Set Peak Limits**
- **Digital Readout Accompanies Each Bar for Accurate Setups**
- **Alternate Display of Processed Audio Levels for Left, Right, Sum, Difference, SAP and PRO**
- **Electroluminescent Bar Graph Display With Precisely Controlled Dynamics**
- **Internal Auto-Calibrator Assures Accurate Modulation Measurements**

The 751 BTSC Aural Modulation Monitor/Decoder provides accurate modulation monitoring and measurement of the BTSC encoded TV sound channel.

The 751 comes ready to monitor the entire BTSC sound channel, including SAP and PRO. Should the needs of your station change, a simple key sequence on the front panel can add or delete SAP or PRO from the display.

Two sets of parameters, peak modulation and processed audio, can be alternately displayed by a simple front panel selection.

Bar graph and digital readout units of measure can be changed from % of maximum to kHz deviation or dB with the simple push of a button.

Also displayed are injection levels for SAP, PRO, and Stereo Pilot, as well as the level of Spurious Stereo Subcarrier.

Instantaneous peak values as well as "held" peak values are displayed as calibrated bars. Each bar is accompanied by a digital readout that corresponds to the "held" peak value. The bar and readout both indicate when an easily set peak limit has been exceeded.

Processing is front-panel selected from Expand, De-emphasis, and Flat. A monitor output is provided on both the front and rear panels for external measurements of the Left and Right stereo channels, SUM, DIFF, SAP, and PRO. A switchable headphone output is also located on the front panel.

Precisely decoded Left and Right stereo channels, SAP, and PRO 600 Ω balanced-line outputs are provided on the rear panel through XLR connectors.

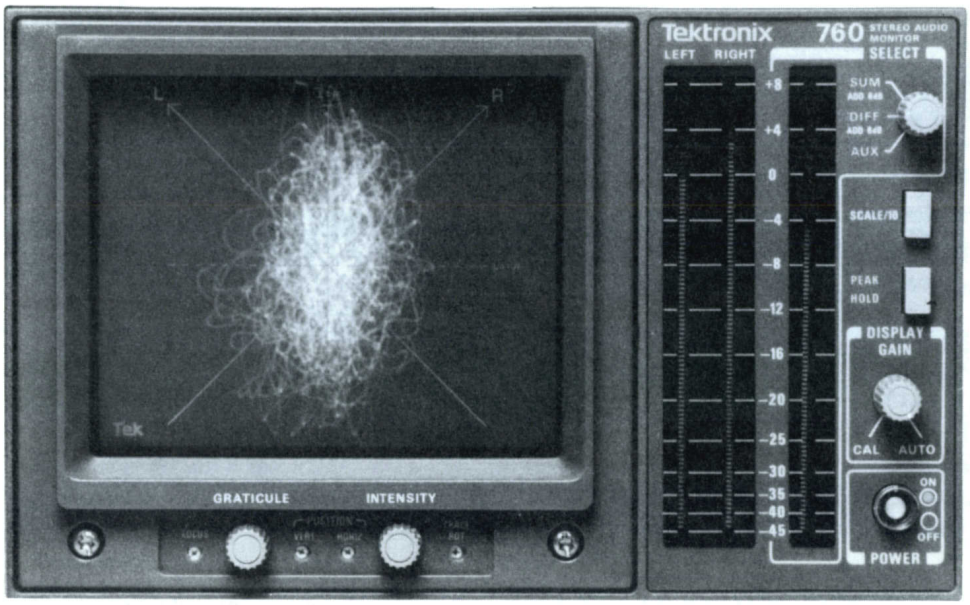
Remote alarm contact closures for No Pilot, Pilot/Sync Unlock and (stereo) Phase/Inverted are provided on the rear panel through a 9-pin D sub-miniature connector. Alarm conditions are also indicated on the display. H sync for measuring Pilot Phase Lock is obtained via the rear panel Composite Video loop-through connector.

The 751 is a 178 mm (7 inch) high, full-rack-width instrument that weighs approximately 13.5 kg (30 lb).

ORDERING INFORMATION

751 BTSC Aural Modulation Monitor/Decoder — **$12,000**

For complete Television product information, request the Television Products Catalog.



760 Stereo Audio Monitor.

760 Stereo Audio Monitor

- **Graphic CRT Display of Stereo Audio Signal**
- **AGC for Continuously Viewable Pattern**
- **Bar Graph for Quick Setups and Accurate Peak Indication**
- **Third Bar Indicates Monaural Levels When Set to SUM**
- **Suitable for Phase and Amplitude Measurements**

With Tektronix' 760 Stereo Audio Monitor, the audio engineer can analyze a pattern display of the stereo audio signal. This display, along with a high-resolution bar graph, provides accurate monitoring and measurement capabilities. Used in both operation and setup, the instrument provides immediate feedback of the audio signal for creative or technical correction. With the appropriate test signals, the unit can also be used for accurate phase and amplitude measurements. On the CRT and adjacent bar graph, you can observe amplitude information, stereo separation, and phase correlation between the Left and Right channels. Also of great importance, you can see monaural amplitudes resulting from the stereo channels.

Your choice of automatic or manual gain control provides flexible control of the pattern size. With no input signal, the display will dim to prolong CRT life.

Two calibrated bars are dedicated to the Left and Right channels. The input to a third bar is selectable from Sum, Difference (both internally derived), and an Auxiliary input on the rear panel. These bars give the operator accurate level indicators featuring a three-second "peak hold" that makes level monitoring easier than ever.

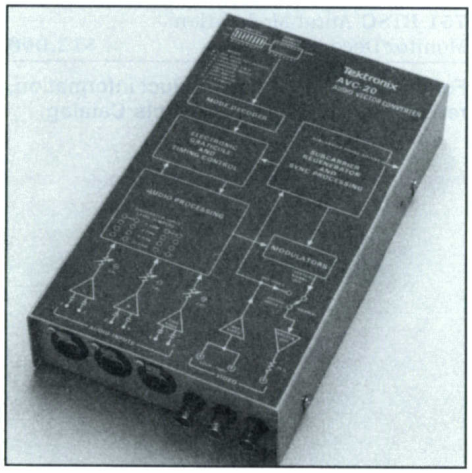
The 760 is ideally suited for use in editing suites, master control, transmission, and any other locations where monitoring the stereo audio signal is a must.

ORDERING INFORMATION

These instruments are configured for rack-mounting and are shipped without cases or covers. Order appropriate optional accessories to configure for rack, bench or portable use. The 760 is a UL recognized component and meets the requirements for listing when used in the appropriate enclosure.

760 Stereo Audio Monitor **$1,990**

Portable Dc Powered Applications
760 Stereo Audio Monitor plus 1700F10 Dc Power Converter, 1700F02 Portable Cabinet, and BP1 Battery Pack.



AVC-20 Audio Vector Converter.

AVC-20 Audio Vector Converter

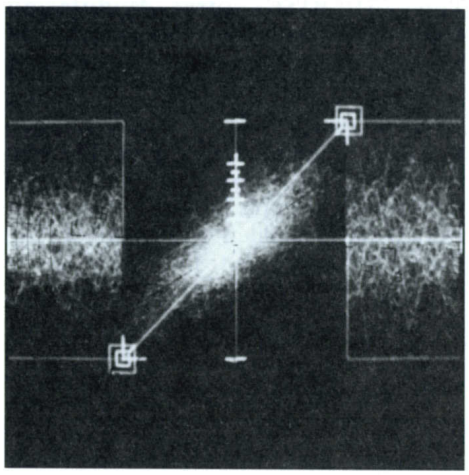
- **For Any NTSC Vectorscope**
- **Balanced Line Level Inputs**
- **Time Code or Third Channel Input**
  - **Field Locked for Time Code Phase**
- **User-Selectable Display Formats**
  - **Lissajous Pattern with Calibrated Amplitude**
  - **Lissajou Pattern and Sweep Displays of Both Channels**
- **Time Versus Amplitude Sweep Display**
  - **Selectable Between All Three Inputs**
  - **Left Plus Right Sweep**
- **Low Power Consumption**
- **Cost Effective**
- **No Front-Panel Space Required**
- **Simple Remote Control**

The AVC-20 provides stereo audio monitoring capability when installed with an NTSC vectorscope. Complete audio monitoring can be added to VTR bridges, master control consoles, and other locations requiring stereo audio monitoring without modifying the vectorscope and without using front-panel space. Stereo phase, individual signal amplitudes, and audio distortions can be observed by simply using the B input to an existing vectorscope. A third audio input channel and a field-locked sweep are available for monitoring time code or a second-language program.

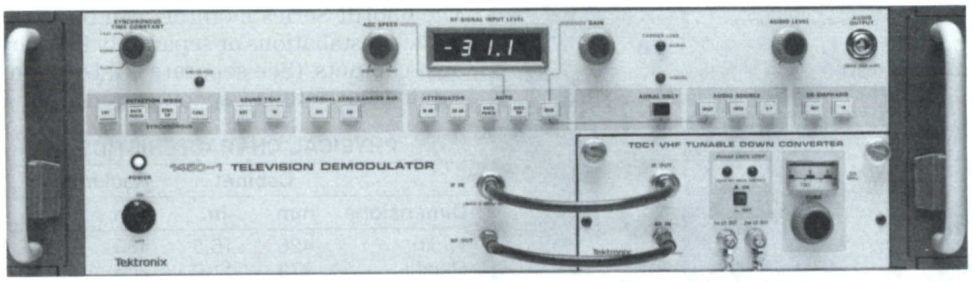
The Tektronix AVC-20 is easy to operate, install, and afford. It's an excellent choice for stereo television facilities.

ORDERING INFORMATION

AVC-20 Audio Vector Converter **$495**



Live audio, left and right channels, time versus amplitude sweep display, and Lissajous pattern (center) with correct stereo phase.



The 1450-1 is compatible with System M Television Transmission, the 1450-2 is compatible with System B/G, and the 1450-3 is compatible with System I.

1450-1/1450-2/ 1450-3

Television Demodulators

- **Measurement-Quality Performance for Negligible Distortion**
- **Synchronous Detection Eliminates Quadrature Distortion**
- **Envelope Detection for Accurately Determined Differential Phase**
- **Surface Acoustic Wave Filter Provides Precise Nyquist Slope; Excellent Long and Short-Term Stability**
- **Digital Readout of Input Power Level for Easy, Accurate Field Strength Readings**
- **Constant-Bandpass Characteristics Over Wide Dynamic Range**
- **Any Single VHF or UHF Channel Operation**
- **UHF and VHF Tunable Down Converters**

The 1450-1 (System M), 1450-2 (System B/G) and 1450-3 (System I) demodulator mainframes are combined with a Tektronix Television Down Converter (TDC) to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible demodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.

ORDERING INFORMATION

SYSTEM M

1450-1 Television Demodulator (Order one Vision IF option) **$14,900**

OPTIONS

Option 01—37 MHz Vision IF. **NC**
Option 02—38.9 MHz Vision IF. **NC**
Option 03—45.75 MHz Vision IF. **NC**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-1 mainframe. Order one Vision IF option and either Option 11 or Option 14.

TDC Fixed Channel Down Converter. Stipulate channel number when ordering. **$4,100**
TDC-1 Tunable Down Converter VHF Band. **$7,660**
TDC-2 Tunable Down Converter UHF Band. **$7,660**
Option 01—37 MHz Vision IF. **NC**
Option 02—38.9 MHz Vision IF. **NC**
Option 03—45.75 MHz Vision IF. **NC**
Option 11—System M Countries.* **NC**
Option 14—Japan and Okinawa. **NC**

FIELD UPGRADE KIT

For upgrading 1450-1 (S/N BO19999 and below) to provide a wide band audio output suitable for use with BTSC System multichannel sound in the U.S. and with stereo sound in Japan.
1450F20—Field Upgrade Kit **$2,150**

* *Except Japan and Okinawa.*

ORDERING INFORMATION

SYSTEM B/G

1450-2 Television Demodulator (Order both Option 02 and Option 09) **$13,145**

OPTIONS

Option 02—38.9 MHz Vision IF. **NC**
Option 09—+90ns/170 ns Group Delay. **NC**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-2 mainframe. Order both Option 02 and Option 12.

TDC Fixed Channel Down Converter. Stipulate channel number when ordering. **$4,100**
TDC-1 Tunable Down Converter VHF Band. **$7,660**
TDC-2 Tunable Down Converter UHF Band. **$7,660**
Option 02—38.9 MHz Vision IF. **NC**
Option 12—System B/G/I countries. **NC**

ORDERING INFORMATION

SYSTEM I

1450-3 Television Demodulator (Order Option 02) **$13,145**

OPTION

Option 02—38.9 MHz Vision IF. **NC**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-3 mainframe. Order both Option 02 and Option 12.

TDC Fixed Channel Down Converter. Stipulate channel number when ordering. **$4,100**
TDC-1 Tunable Down Converter VHF Band. **$7,660**
TDC-2 Tunable Down Converter UHF Band. **$7,660**
Option 02—38.9 MHz Vision IF. **NC**
Option 12—System B/G/I Countries. **NC**

ORDERING INFORMATION

SYSTEMS D AND K

1450 Series Television Demodulators and Down Converters with modifications. Contact Tektronix for quote.

For complete Television product information, request the Television Products Catalog.

650HR-C Series Component/Composite Picture Monitor.

650HR Series Color Picture Monitors

- **High-Resolution Display Plus Capability for Critical Signal Analysis**
- **0.25 mm Triad Pitch High-Resolution Trinitron® CRT**
- **Variable Aperture Correction**
- **Precise Color Tracking Over Full Signal Range**
- **Two Video Inputs With Differential (A-B) Capability**
- **Video Inputs Isolated from Ground for Hum Rejection**
- **NTSC, PAL, SECAM, and Multistandard Versions Available**
- **Precise Decoders With Outputs to Provide Vector Display on External X, Y Monitor**
- **Patented Monochrome (White) Display of Decoded Blue Signal for Critical Analysis of Color Noise**

The Tektronix 650HR Series color picture monitors are designed for exacting applications where picture quality and signal quality analysis are particularly important.

Circuits in the Tektronix 650HR Series are designed for color stability and consistency. Outputs are provided from the precision decoders and may be used to drive an X,Y monitor for a vector display. The regulated high-voltage supply is not affected by extreme changes in APL even when calibrated brightness, at peak white, is set at 30 fL. Raster size is held within 1%, while excellent clamping maintains a stable black level with a 0% to 100% range of APL.

In 650HR Series color monitors, you can shift the picture either horizontally or vertically, or both (pulse cross). This capability lets you monitor sync, burst, blanking, vertical interval test, and reference signals. Expansion of the vertical scan is provided in the pulse cross and vertical delay modes, so you can view individual lines in the vertical blanking interval.

The patented blue only mode feeds the decoded blue video signal to the red, green, and blue channels simultaneously. This produces a monochrome display with a high subjective sensitivity to chroma noise, allowing better analysis of video quality.

The chrominance channel may be manually switched to either the monochrome or color modes, or activated automatically by the presence of burst.

The following special features are included in the SECAM version: color sequencing from field identification signals or line burst; reduced chrominance line crawl; color sequence error indicator.

Versions of the 650HR are available for certain combinations of NTSC, PAL, SECAM and parallel components. (See ordering information chart.)

The 650HR Series monitors can be used in rack installations or separately in their own cabinets. (See separate TV Division catalog for detailed specification.)

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	426	16.8	483	19.0
Height	279	11.0	266	10.5
Depth	419	16.5	464*1	18.3*1
Weights	**kg**	**lb**	**kg**	**lb**
Net	22.7	50.0	23.5	52.0
Domestic Shipping	28.5	65.0	30.4	67.0
Export Shipping	36.3	80.0	37.2	82.0

* *With handles.*

650HR-C Series Component/ Composite Input Picture Monitors

- **Direct Analog Component Inputs**
- **SMPTE Parallel, Betacam™, MII, M, or GBR Formats**
- **Composite Decoding—NTSC or PAL**
- **Multistandard Capability**

Tektronix' 650HR monitors are now available with direct analog component inputs. The new "C" models are replacing the previous "1" to provide input capability for SMPTE Parallel, Betacam™, MII, M, or GBR analog component formats.

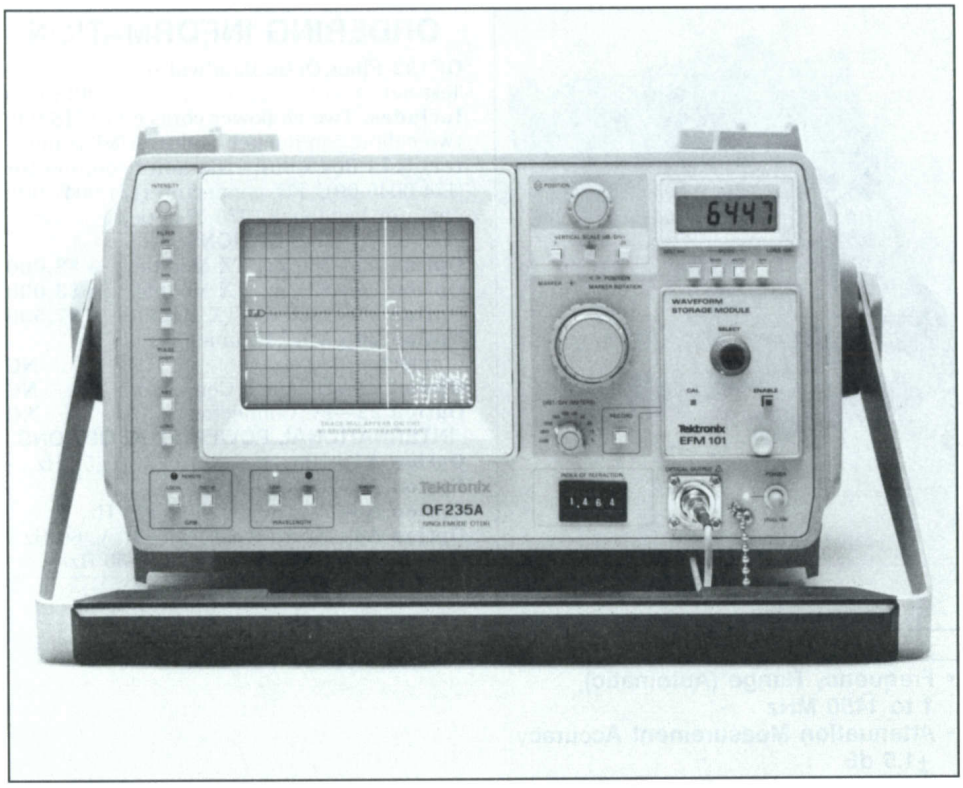
The RGB input circuitry has been replaced with a DIP switch programmable component transcoder. Internal switches program the 650HR-C's transcoder for one of the parallel analog component formats. Front panel switching then selects either the component or composite input for display. This allows monitoring the quality of your video before and after encoding to composite.

ORDERING INFORMATION

All 650HR Monitors are shipped with rack-mounting hardware. Cabinet version hardware is also included.

Model Number	NTSC	PAL	SECAM	Component	Price
650HR	•				$4,950
650HR-C	•			•	$5,300
651HR		•			$5,165
651HR-C		•		•	$5,515
652HR-1		M		*	$5,875
655HR-C	•	•		•	$6,100
656HR-1		•	•	*	$6,750

* *G, B, R format only.*



OF235A/OF152/OF150 Fiber Optic Cable Testers

- Singlemode and Multimode Environments
- 850 to 1550 nm
- LCD Readout
- Accurate, Repeatable Measurements
- Optional Chart Recorder, Optional Recorder Output
- Digital Storage With Easy-To-View Waveform and Noise Reduction
- Selectable Pulse Widths
- Rugged and Portable—Operates From 12-Volt Vehicle System or Battery Pack

NEW OF235A

Fiber Optic TDR

GPIB IEEE-488 — The OF235 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- Dual Wavelength
- Auto Masking
- 1300/1550 nm Switchable GPIB
- Three Loss-Measurement Modes
- Connectors Available: AT&T Biconic, FC, NEC, Diamond 3.5, Diamond 2.5, Radiall
- 0.25-dB/Div Vertical Scale
- 1-Meter Distance Resolution

OF152/OF150

Fiber Optic TDR

- 1300 nm (OF152)
- 850 nm (OF150)
- Connectors Available: AT&T Biconic

ORDERING INFORMATION

OF235A Fiber Optic Time Domain Reflectometer — $28,500
OF152 Fiber Optic Time Domain Reflectometer — $17,500
OF150 Fiber Optic Time Domain Reflectometer — $13,500

OPTIONS

Option 01—XY1 Output Module. + $300
Option 04—Chart Recorder. + $1,050
Option 07—(OF235A) Delete 1550 nm. – $9,000
Option 20—AT&T Biconic Connector. NC
Option 21—(OF150) Diamond 3.5 Connector. NC
Option 22—(OF150, OF235A) FC Connector. NC
Option 23—(OF150) SMA Connector. NC
Option 23—(OF235A) NEC Connector. NC
Option 24—(OF235A) Diamond 2.5 Connector. NC
Option 25—(OF235A) Radiall Connector. NC
Option 26—(OF150) ST Connector. NC
Option 27—(OF150) Deutsch Connector. NC

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz
Option A2—UK 240 V, 50 Hz
Option A3—Australian 240 V, 50 Hz
Option A4—North American 240 V, 60 Hz
Option A5—Switzerland 220 V, 50 Hz

OPTIONAL ACCESSORIES (OF235, OF152, OF150)

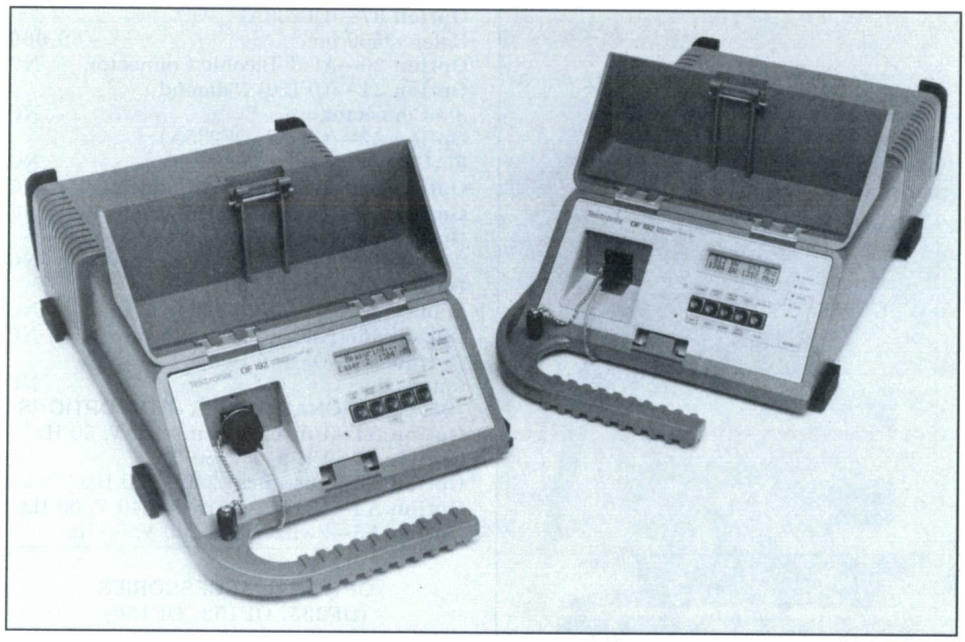
C-5C—Camera. $495
C-7—Camera. $595
Cases—(Transit) Order 016-0658-00. $795
(Soft) Order 016-0659-00. $130
Receptacle Connector, Optical—Ten each. Order 013-0207-02. $450
Chart Paper—
(One Roll) Order 006-3618-00. $10
(25 Rolls) Order 006-3618-01. $230
(100 Rolls) Order 006-3618-02. $750
Accessory Kit—Deutsch Tools and Plugs. Order 015-0474-00. $900
Sun Visor—Order 016-0653-00. $35
XY1 Output Module $350
Chart Recorder—Order 016-0506-07. $1,150
Cable Assemblies—
(Diamond-to-AT&T Biconic) Order 175-9708-00. $600
(Diamond-to-FC) Order 175-9707-00. $560
(Diamond-to-Diamond) Order 175-9695-00. $600

ADDITIONAL INFORMATION

Brochures—
(OF150 Series) Order 22-W-5847.
(OF235A) Order 22-W-5987-2.

PORTABLE FIBER OPTIC CABLE TESTERS

Instrument Type	Type	Wavelength (nm)	Fiber
OF235A	OTDR	1300/1550	Singlemode
OF235A Option 07	OTDR	1300	Singlemode
OF152	OTDR	1300	Multimode
OF150	OTDR	825/850	Multimode
OF192	Bandwidth Test Set	825/850/1300	Multimode



ORDERING INFORMATION

OF192 Fiber Optic Bandwidth Test Set **$32,000**

Includes: Two ac power cords (161-0118-00); two calibration jumper cables; AT&T connector (174-0043-00); Diamond connector (174-0045-00); FC connector (174-0047-00); operator handbook (070-5744-00).

OPTIONS

Option 05—850 nm TX Module. **+$3,000**
Option 06—825 nm TX Module. **+$3,000**
Option 07—1300 nm TX Module. **+$7,500**
Option 20—AT&T Biconic Connector. **NC**
Option 21—Diamond Connector. **NC**
Option 22—FC Connector. **NC**

INTERNATIONAL POWER PLUG OPTIONS

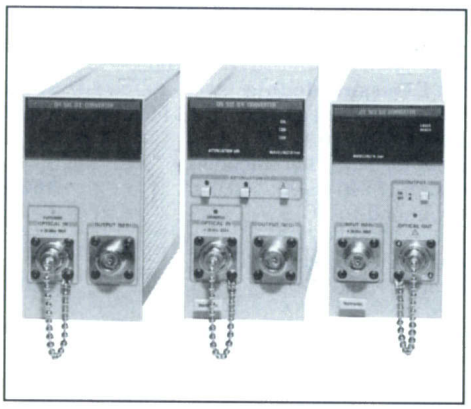
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OF192 Fiber Optic Bandwidth Test Set

GPIB IEEE-488

The OF192 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Frequency Range (Automatic) 1 to 1450 MHz**
- **Attenuation Measurement Accuracy ±1.5 dB**
- **Connectors: AT&T Biconic, FC, Diamond**
- **Operating Temperature: 0 to +50°C**



OT501/OT502/ OT503 Transmitters
OR501/OR502 Receivers

Electrical/Optical, Optical/Electrical Converters

The OT501/502/503 Transmitters and OR501/502 Receivers are designed to transmit and receive signals across fiber. The receivers can be used to convert most instruments to optical instruments (e.g., the optical scope). The transmitters and receivers are designed as a TM 500 plug-in to be used in any TM 500 or TM 5000 mainframe. Diamond 3.5 mm connector is standard.

OT501/502/503 TRANSMITTERS

	OT501	OT502	OT503
Wavelength	825±15 nm	850±10 nm	1300±25 nm
FWHM*	<2 nm		<4 nm
Output Power, DC	+3 dBm		0 dBm
Mod Input	50 Ω		
Mod Input Level: Max	+20 dBm		
Mod Input Level: w/100% Mod	<0 dBm		
Mod Freq Response	0.03 to 1700 MHz		0.03 to 1500 MHz
Mod Flatness	±1 dB (0.05 to 1000 MHz)		
	±2 dB (0.03 to 1700 MHz)		±5dB (0.03 to 1500 MHz)

OR501/502 RECEIVERS

	OR501	OR502
Wavelength	700 to 1500 nm	
Photo Element	Ge-APD	
Max Linear Input	−20 dBm	+10 dBm
Frequency Response	0.03 to 1500 MHz±2 dB 0.05 to 1000 MHz±1 dB	
Noise Floor	≤−110 dBm/Hz	
Output 50 Ω	−15 dBm typical for −20 dBm optical input	−12 dBm typical −20 dBm optical input
Optical Attenuator	N/A	2.5 dB/step (Norm) 37.5 dB (Max)

* *Full width half maximum.*

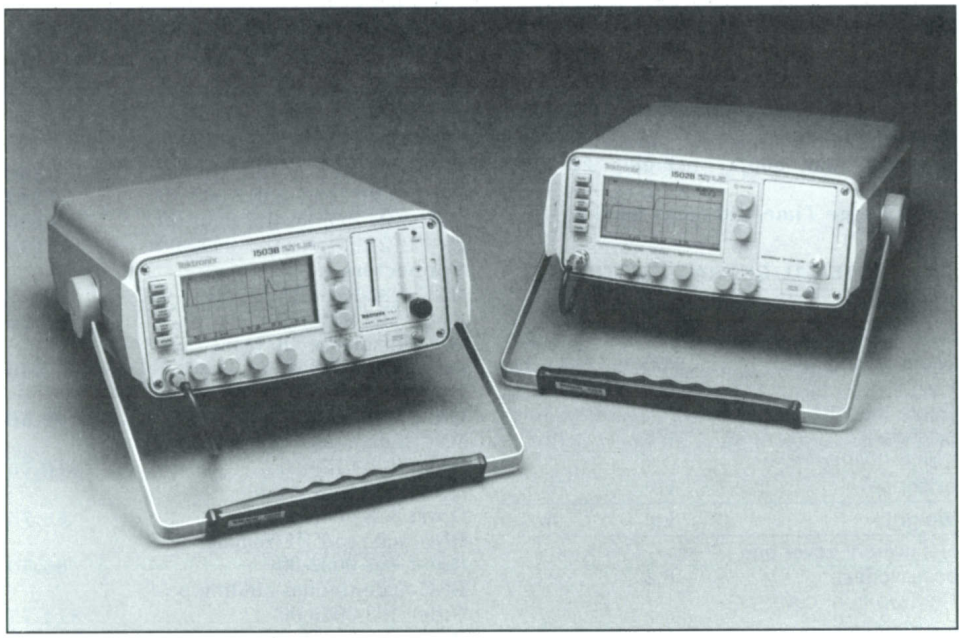
ORDERING INFORMATION

OT501 825 nm E/O Converter **$5,900**
OT502 850 nm E/O Converter **$5,900**
OT503 1300 nm E/O Converter **$9,500**
OR501 O/E Converter **$4,300**
OR502 O/E Converter **$6,500**

OPTIONS

Option 01—Diamond-to-SMA Cable **NC**
Option 20—AT&T Biconic Connector **NC**
Option 22—FC Connector **NC**

Tektronix Metallic Cable Testers: Accurate Time Domain Reflectometry for Telephony, LAN, On-Board System, Sensor Network, and CATV Applications



NEW 1502B/1503B

Metallic TDR Cable Testers

- **Portable: Battery Power (Optional), Self-Contained, Lightweight**
- **Meets Type III, Class 3, Style A Environmental Characteristic as Prescribed by MIL-T-28800**
- **Versatile: Test Any Type Paired Conductor and Coax Cable**
- **Easy to Use: Produces Results with Minimal Operator Training**

Time Domain Reflectometry (TDR)*1

The portable, rugged 1502B and 1503B TDR Cable Testers are field maintenance tools that are simple to operate and will test any transmission cable under virtually any condition. These units use a technique called Time Domain Reflectometry (TDR) to identify and locate cable faults. The unit is connected to a line in the cable and sends out an electrical pulse that is reflected back to the unit by a fault in the cable. Fault type is identified by the shape of the display. The display is an LCD where distance measurements may be made using a cursor.

The 1502B tests coax and other cables in aircraft, ships, radar sites, etc. The 1503B tests long runs of coax or twisted pair cables in telephone and other communications applications.

*1 *Also known as cable radar.*

Both units are small and lightweight for easy carrying and operating in tight spaces. The optional battery pack (Option) will provide at least five hours of operation.

1502B

This unit is directly calibrated in reflection coefficient (rho) and distance. The 1502B uses a step-pulse and provides fault resolution to 0.9 inch on short cables. The 1502B performs to a maximum of 2000 feet, but with decreasing resolution as the fault distance increases. The unit is matched to 50-ohm cables, but may be used on others by adjusting the front panel vertical scale control or using optional impedance adapters.

1503B

The 1503B provides high-energy, ½-sine-shaped pulses for long cables. Range of the 1503B, dependent upon cable type, is up to 50,000 feet. Resolution capability provides for resolving faults as close together as one foot on short cables. Impedance levels of 50, 75, 93, and 125 ohms are selectable.

Metric Instruments

For distance measurements in meters, Option 05 is available for both the 1502B and 1503B. These instruments are complete metric versions of the 1502B and 1503B (no conversion from feet to meters is involved). Both the 1502B and 1503B also offer feet to metric conversion via Menu.

The 1502B Option 05 has a distance resolution of 24 mm and measures 500 meters.

The 1503B Option 05 has a resolution of 0.3 meter and measures 10 000 meters.

Chart Recorder YT1

For permanent records of cable tests, the Option 04 plug-in chart recorder (thermal dot matrix) is available for both the 1502B and 1503B.

Menu

The 1502B and 1503B offer the operator a variety of parameters and information which can be acquired using the Menu feature. The main menu allows the user to access: Help with the instrument controls; velocity of propagation and impedances of different cable types; instrument/front panel configurations; and instrument diagnostics.

CHARACTERISTICS

1502B METALLIC TDR CABLE TESTER

Test Signal—Step rise ⎍.
Amplitude—300 mV nominal into 50 Ω load.
System Risetime—200 ps (1.15 in./2.92 cm).
Output Impedance—50 ohms ±1%.
Electrostatic Discharge Protection—1 kV/500 pF capacitor/1 k resistance.
DC Input Protection—±1 A.
Maximum Range—2,000 ft/500 meters.
Distance Readout Resolution—0.12 in./0.30 cm.
Noise Filtering—1 to 128 averages.
Vertical Scale—0.5 to 500 mρ/div.
Dist/Div—0.1 to 200 ft/div; 0.025 to 50 m/div.
Environmental—Meets capabilities of a Type III, Class 3, Style A instrument as prescribed by MIL-T-28800.

1503B METALLIC TDR CABLE TESTER

Test Signal—½ sine.
Amplitude—Terminated: −2.5 V. Unterminated: −5.0 V.
Pulsewidths—2, 10, 100, 1000 nsec.
Output Impedance—50, 75, 93, 125 Ω.
Input Protection—±400 V (dc + peak ac).
Maximum Range—50,000 ft/10 000 meters.
Distance Readout Resolution—1.2 in./3.0 cm.
Noise Filtering—1 to 128 averages.
Vertical Scale—0 to 63.75 dB Gain.
Dist/Div—1 to 5000 ft/div; 0.25 to 1000 m/div.
Environmental—Meets capabilities of a Type III, Class 3, Style A instrument as prescribed by MIL-T-28800.

COMMON CHARACTERISTICS

The following characteristics are common to both the 1502B and 1503B.

POWER REQUIREMENTS

AC Power—Line Voltage: 115 V ac (90 to 132 V ac) and 230 V ac (180 to 250 V ac). Line Frequency: 45 to 440 Hz.
DC Power—Battery Pack Operation (Option 03): At least 5 hours (15 to 25°C charge and discharge temperature), no chart recordings. At least four hours, including 20 chart recordings.
Full Charge Time—20 hours maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width (w/handle)	315	12.4
Width (w/o handle)	300	11.8
Height	127	5.0
Depth (handle extended)	475	18.7
Depth (handle not extended)	419	16.5
Weight ≈	**kg**	**lb**
Net (w/front cover and accessories)	8.2	21
Net (w/o front cover or accessories)	7.3	15
Domestic Shipping (complete) ≈	11.1	27
Export Shipping (complete) ≈	16.3	42

ORDERING INFORMATION

1502B Metallic TDR **$5,525**
Includes: AC power cord; 50 Ω BNC terminator (011-0123-00); precision 50 Ω cable (012-0482-00); female-to-female BNC connector (103-0028-00); spare fuse; operator's manual (070-6266-00).
1503B Metallic TDR **$4,200**
Includes: AC power cord, 50 Ω BNC terminator (011-0123-00); precision 50 Ω cable (012-0482-00); spare fuse; 9 ft BNC-to-clip lead cable (012-0671-02); operator's manual (070-6268-00).

OPTIONS

Option 03—Battery Pack +**$175**
Option 04—YT1 Chart Recorder +**$950**
Option 05—Metric Version **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz
Option A2—UK 240 V, 50 Hz
Option A3—Australian 240 V, 50 Hz
Option A4—North American 240 V, 60 Hz

OPTIONAL ACCESSORIES (1502B/1503B)

Battery Pack—Order 016-0813-00*1
YT1 Chart Recorder—
Chart Paper—
(1 roll) Order 006-7647-00*1
(25 rolls) Order 006-7677-00*1
(100 rolls) Order 006-7681-00*1
Terminator—75 Ω BNC.
Order 011-0102-00 **$18.75**

(1502B only)

Service Manual—Order 070-6267-00*1
Adapters—
(Direct Current) Order 015-0327-00 **$260**
(50/125 Ω)*2 Order 017-0090-00 **$195**
(50/75 Ω)*2 Order 017-0091-00 **$195**
(50/93 Ω)*2 Order 017-0092-00 **$195**
Connectors—
BNC female-to-BNC male.
Order 103-0045-00 **$8.25**
BNC female-to-clip leads.
Order 013-0076-00 **$40**
BNC female-to-dual banana plug.
Order 103-0090-00 **$9.50**
BNC female-to-F male.
Order 103-0158-00 **$10.75**
BNC male-to-N female.
Order 103-0058-00 **$8.75**
BNC male-to-UHF female.
Order 103-0032-00 **$6.50**
BNC male-to-dual binding post.
Order 103-0035-00 **$14.75**
(GR-to-BNC male)
Order 017-0064-00 **$100**
(GR-to-BNC female)
Order 017-0063-00 **$55**

(1503B only)

Service Manual—Order 070-6269-00*1
Isolation Network—Order 013-0169-00 **$275**
Connectors—
BNC female-to-clip leads.
Order 013-0076-00 **$40**
BNC male-to-female.
Order 013-0058-00*1
BNC female-to-dual banana plug.
Order 103-0090-00 **$9.50**
BNC male-to-dual binding post.
Order 103-0035-00 **$14.75**
BNC male-to-BNC male.
Order 103-0029-00 **$8**
BNC female-to-UHF male.
Order 103-0015-00 **$5.75**
BNC female-to-UHF female.
Order 103-0032-00 **$6.50**
BNC female-to-type F male.
Order 103-0158-00 **$10.75**

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

*1 *Contact your local sales office.*
*2 *Should be purchased with the following connectors: BNC female-to-GR 017-0063-00; BNC male-to-GR 017-0064-00.*

DATA COMMUNICATIONS ANALYZERS FROM TEKTRONIX: SOLVING PROBLEMS IN A COMPLEX NETWORK WORLD

834/835/836
Data Communications Analyzers

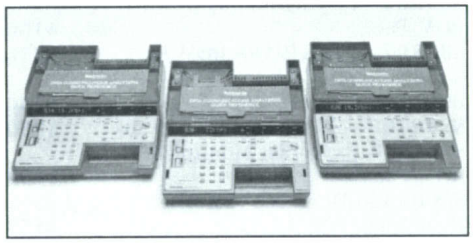
- Instruments are Lightweight, Rugged and Portable
- Multiple Triggers—Trigger on Selected Control Line Changes, Error Conditions or Character Strings, Both Masked and Unmasked
- The ROM Development Aid (830RDA) Gives Users the Ability to Automate and Extend Capabilities
- Other Application ROM Packs Contain Software to Expand the Analyzer Capabilities and Preprogrammed Test Routines Dedicated to Specific Applications
- Three-Year Warranty

835/836
Data Communications Analyzers

- Uploads Data, Downloads Programs Between Analyzer and Host or Analyzer to Analyzer
- Nonvolatile Memory—Automatically Retains All Programs, Set-Ups and Captured Data
- Application RAM and ROM Packs—Memory Packs Provide Removable Storage (RAM) of Data and Programs Plus Application Programs (ROM). Library Packs Allow Multiple Selection of Application Software Through User-Selectable ROM Banks

836 Data Communications Analyzer

- High Speed, Up to 72 kbps, All Modes, 144 kbps Half-Duplex Monitor
- Data Compression Prevents Buffer From Filling Up with Idle Frames in HDLC



ORDERING INFORMATION

836 Programmable Data Communications Analyzer **$3,495**
835 Programmable Data Communications Analyzer **$2,750**
834 Programmable Data Communications Analyzer **$1,995**

INTERFACE OPTIONS

Option 02—Current Loop Interface. **+$400**
Option 03—RS-449 (RS-422/RS-423) Interface. **+$400**
Option 04—MIL-STD-188C Interface. **+$400**
Option 05—Two-Wire Direct Interface. **+$400**
Option 06—V.35 Interface. **+$400**
Option 09—X.21 Physical Interface (A6747) **+$400**

SPECIAL PACKAGES AND APPLICATIONS

835BS Bisynchronous/SDLC/SNA Package **$3,260**
Includes: 835; 830L02; Software; Case.
835SL Selection Package **$3,550**
Includes: 835; 830L03; Software; Case.
835PR PARS/IPARS Package **$2,980**
Includes: 835; 830R07; Case.
836DV Development Package **$4,205**
Includes: 836; 830M09; Software; Case
836CL Current Loop Package **$3,975**
Includes: 836; 02 Current Loop Interface; Case.

TV ANALYZERS

836TV Television Production Protocol Analyzer **$4,405**
Includes: 836; 836L18; A6746; case.
836L18 Television Production Library Pack **$430**
Includes: TV software (Ampex, Sony BVU-800/ BVH-2000, GVG 100/300, EBU/SMPTE).
A6746 EBU/SMPTE Bus Interface **$400**

ROM PACKS

830RDA—ROM Development Aid **$150**
830R01—Asynchronous ROM Pack **$150**
834R02A—Bisynchronous (EBCDIC) ROM Pack **$150**
830R02B—Bisynchronous ROM Pack **$250**
830R03—Link Test ROM Pack **$150**
830R03B—Link + Async ROM Pack **$250**
834R04—HDLC/X.25 ROM Pack **$150**
834R05—Extended Instruction ROM Pack **$70**
834R06—Bisynchronous (ASCII) ROM Pack **$150**
830R07—PARS/IPARS ROM Pack **$375**
830R10—SDLC/SNA (FID2) ROM Pack **$150**
830R10B—SNA (FID2) ROM Pack **$250**
834R11—Extended Monitor ROM Pack **$150**
830R13—SDLC/SNA (FID3) ROM Pack **$150**
830R31—Multipurpose ROM Pack **$250**
Option 12—(834R02A, 834R06, 830R10, 830R13 ROM Packs only) Download with ATT Application*1

*1 *Contact your local sales office.*

LIBRARY PACKS (835/836 only)

The library and memory packs may be specified to contain one software option for each 16K ROM bank.

Product	Memory	Banks	Price
830L01	32K	2	$120
830L02	64K	4	$170
830L03	128K	8	$200

830L30—IBM Solutions Library Pack **$550**

MEMORY PACKS (835/836 only)

Product	RAM	Banks	ROM	Banks	Price
830M07	48K	3			$325
830M08	48K	3	16K	1	$390
830M09	48K	3	64K	4	$500

SOFTWARE OPTIONS (Memory & Library Packs)

Option 0B—830S0B SNA(FID2)*1
Option 01—830S01 Asynchronous. **+$65**
Option 02—830S02 Bisync (EBCDIC). **+$65**
Option 03—830S03 Link Test. **+$65**
Option 04—830S04 HDLC/X.25. **+$65**
Option 06—830S06 Bisync (ASCII). **+$65**
Option 1A—830SDA ROM Development Aid. **+$65**
Option 10—830S10 SDLC/SNA (FID2). **+$65**
Option 11—830S11 Extended Monitor. **+$65**
Option 13—830S13 SDLC/SNA (FID3). **+$65**
Option 2A—830SDA with Option 01. **+$65**
Option 2B—830S2B Bisynchronous*1
Option 3B—830S3B Link and Async*1

TV SOFTWARE OPTIONS

Option 19—Ampex VPR3/VPR6. **+$65**
Option 20—Sony BVU-800/BVH-2000. **+$65**
Option 21—GVG 100/300. **+$65**
Option 22—EBU/SMPTE (ESbus). **+$65**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz
Option A2—UK 240 V, 50 Hz
Option A3—Australian 240 V, 50 Hz
Option A4—North American 240 V, 60 Hz
Option A5—Switzerland 220 V, 50 Hz

OPTIONAL ACCESSORIES

Service Manual—Order 070-5600-00 **$105**
Carrying Case—Order 016-0672-00 **$85**
Large Carrying Case—Order 016-0812-00 **$100**
Shielded "T" Cable—Order 175-9709-00*1
RS-232 V.24 Tri-State Break-Out Box—Order A6743 **$265**
Interface Adaptors—
(RS-449) Interface. Order A6741 **$400**
(Two-Wire) Order A6742 **$400**
(V.35) Order A6744 **$400**
(Current Loop) Order 015-0361-00 **$450**
(X.21) Physical Interface. Order A6747 **$400**

New accessories continually being introduced. Please check with Sales Engineer at local Sales Office.

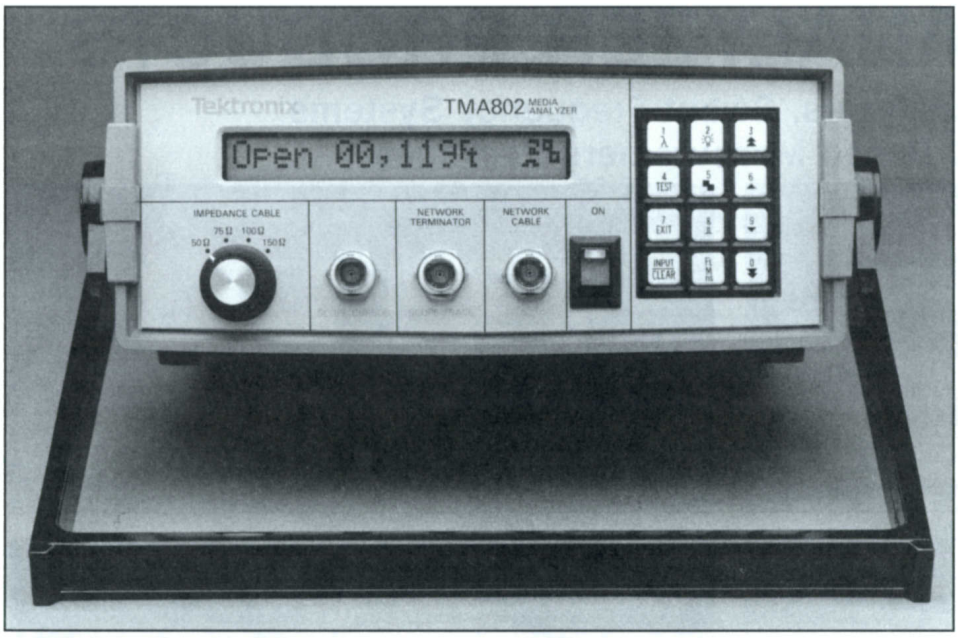
ADDITIONAL INFORMATION

830 Series Brochure—Request 22-W-5910
830 Series Selection Guide—Request 22-W-5901
Essentials of Data Communications—Request 062-8101-00
Getting Started with Your Data Communications Analyzers—Request 22-W-6243

A variety of training accessories are also available including workbooks, videotapes, etc.

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.



NEW TMA802

Media Analyzer

- **Comprehensive LAN Media Analyzer**
  - **Test Cable Quickly and Accurately**
  - **Monitor Network Traffic Load**
- **Nonintrusive Testing of LANs**
  - **Network Can Continue to Operate While Cable is Tested**
- **Effectively Monitors Traffic in Multivendor Networks**
- **Capable of Testing Coax or Twisted-Pair Based LANs**
- **Supports the Entire Family of IEEE 802 LANs**
  - **IEEE 802.3 10Base5 Ethernet**
  - **IEEE 802.3 10Base2 Cheapernet**
  - **IEEE 802.3 1Base5 Starlan**
  - **IEEE 802.4 MAP Token Bus**
  - **IEEE 802.5 IBM Token Ring**
- **Quick, Easy-to-Use Standalone Operation or a Detailed View of the Network with TEK 2225 50 MHz Scope**
- **Reports Distance in Feet or Meters, or Roundtrip Propagation Delay in μsec**
- **Rugged, Portable 8-lb, Battery-Power**

The TMA802 can accurately evaluate the condition of the network cable and can effectively monitor the traffic load on a LAN. The TMA802 was specifically designed to test LANs and is compatible with the entire family of IEEE 802 networks. A variety of Network Kits facilitates interfacing to each of these LANs. Its nonintrusive nature means the LAN can continue to operate while the TMA802 test the media. The TMA802's three powerful modes of operation make it the most comprehensive LAN Media Analyzer on the market.

Standalone Mode:

The Standalone mode provides a quick and unambiguous means to pinpoint the location of any major fault that can disrupt the network. It is particularly well suited for Computer service personnel that may not be familiar with the intricacies of making complex cable measurement.

In the Standalone mode, it tests the LAN cable and accurately reports its status in plain English via 16 character LCD.

"OK to 500 M"
"OPEN 1640 ft"
"SHORT 615 ft"

Scope Mode

When a more detailed inspection of the network is needed, the TMA802 can be coupled with an oscilloscope to provide an accurate and detailed view of the entire network including transceiver, terminator, and multiple faults.

The TMA802 was designed to work with the new low-cost professional quality TEK 2225 or with the industry standard 2465. It will also operate with other oscilloscopes with a minimum 50 MHz bandwidth. Physical adapters are available to mate the TMA802 into an-easy-to transport single system with 2200 and 2400 series oscilloscopes.

Monitor Mode

The Monitor mode is very useful in multivendor networks where the absence of a standard network management system makes traffic load measurements extremely difficult or expensive. These traffic measurements can be used to isolate network problems, or can be used as a guide when expanding the network, or to facilitate the fine tuning of network devices to optimize overall network performance.

The TMA802 provides a direct indicator of network utilization independent of the protocol. Utilization is reported in terms of percentage of network bandwidth being used:

- over the last two seconds
- over the last minute
- since the instrument was reset.

CHARACTERISTICS

ELECTRICAL

Pulse Width: 15, 150, 110 ns, 37 μs.
Pulse Amplitude: −2 V.
Output Impedance: 50, 75, 100, 150 Ω.
Accuracy: ±4 to 1000 ft.

ENVIRONMENTAL

Temperature—Operating: −20 to +50°C. Nonoperating: −30 to +60°C.
Altitide—Operating: 15,000 ft. Nonoperating: 50,000 ft.
Humidity—90% noncondensing.
EMI—FCC Part 15, Subpart J, Class A, VDE 0871, Class B.

BATTERY

Can operate indefinitely from its charger.
Operating—Three hours.
Charging—Five hours to full charge.
Type—Sealed lead-acid, 2.6 amp/hr..

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	250	9.8
Height	90.0	3.5
Depth	403	15.8
Weight	**kg**	**lb**
Net	3.7	8.1

ORDERING INFORMATION

TMA802 Media Analyzer **$2,495**
Includes: Four BNC terminators, 50 Ω (011-0141-00), 75 Ω (011-0142-00), 100 Ω (011-0143-00), 150 Ω (011-0144-00), 16 ft BNC-to-BNC 50 Ω cable (174-0533-00), battery charger (119-2731-00), operator's manual (070-6273-00).

INTERNATIONAL BATTERY CHARGERS

Option 1C—Universal Euro 220 V, 50 Hz*1
Option 2C—UK 240 V, 50 Hz*1
Option 6C—Canada*1

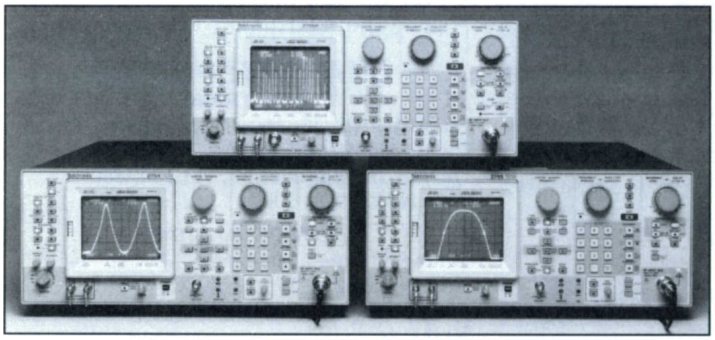
OPTIONAL ACCESSORIES

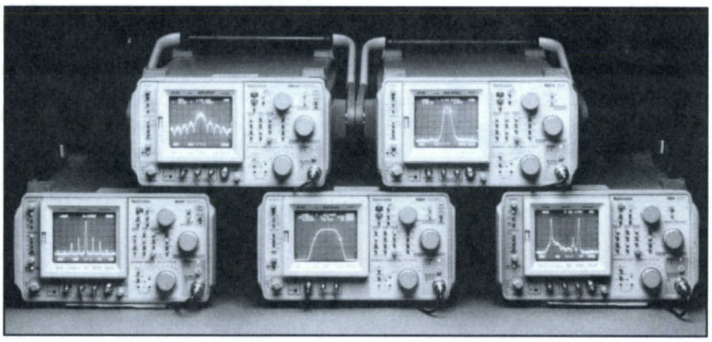
Network Kits
IEEE 802.3 10Base5 Ethernet/ Cheapernet*2
IEEE 802.3 1Base5, Starlan*1
IEEE 802.4—MAP Token Bus, Broadband/CATV.*2
IEEE 802.5 IBM Token Ring*1
Scope Connector/Cable Kit*2
Scope Cameras
C4—For use on scopes with graticle illumination. **$375**
C7—With flash. **$595**
Physical Scope Adapter Kits
2200 Series—Order 014-0066-00 **$60**
2400 Series—Order 014-0067-00. **$60**
Carrying Case—Order 016-0817-00.*1

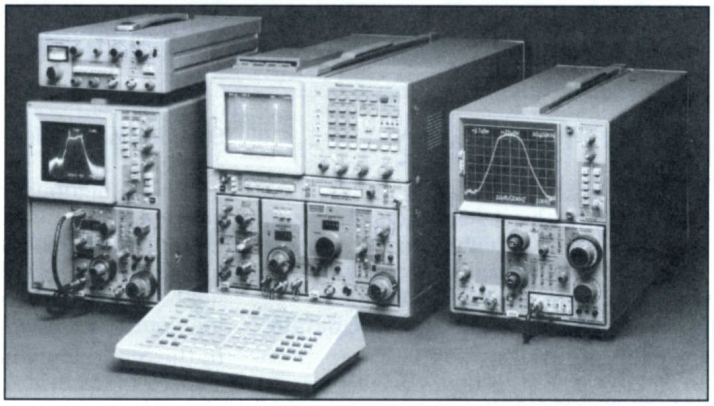
*1 *Available Fall 1987*
*2 *Contact your local sales office.*

SPECTRUM ANALYZER PRODUCTS

Spectrum Analyzers, Swept Frequency Systems And PC Based Measurement Packages







CONTENTS

Spectrum Analyzers Selection Guide 163

Laboratory Spectrum Analyzers
NEW 2753P Programmable 100 Hz to 1.8 GHz 168
NEW 2756P Programmable 10 kHz to 325 GHz 171
2755 50 kHz to 325 GHz 174
2755P Programmable 50 kHz to 325 GHz 174
2754 50 kHz to 21 GHz 176
2754P Programmable 50 kHz to 21 GHz 176

Portable Spectrum Analyzers
NEW 494A 10 kHz to 325 GHz . . . 180
NEW 494AP Programmable 10 kHz to 325 GHz 180
495 100 Hz to 1.8 GHz 184
495P Programmable 100 Hz to 1.8 GHz 184
492A 50 kHz to 325 GHz 187
492AP Programmable 50 kHz to 325 GHz 187
494 10 kHz to 325 GHz 190
494P Programmable 10 kHz to 325 GHz 190
496 1 kHz to 1.8 GHz 190
496P 1 kHz to 1.8 GHz 190

Waveguide Mixers 191

Economy Portable Spectrum Analyzer
2710 10 kHz to 1.8 GHz 192

Spectrum Analyzer Systems 194

Software 195

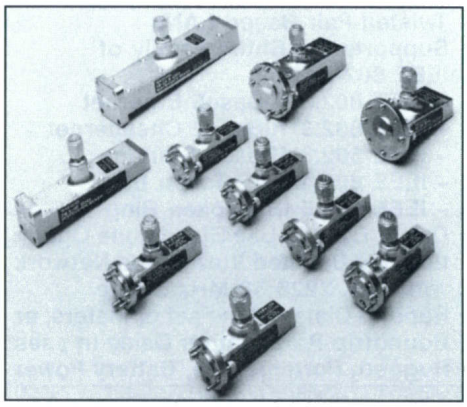
MMIC Packages 197

Plug-In Spectrum Analyzers
7L5 20 Hz to 5 MHz 198
7L14 10 kHz to 1.8 GHz 200
7L12 100 kHz to 1.8 GHz 200

Tracking Generator
TR 502/TR 503
100 kHz to 1.8 GHz 201

TV Sideband Adaptor
1405 201

Spectrum Analyzer Accessories . 202



WM490 Series Waveguide Mixers

SPECTRUM ANALYZER PRODUCT SELECTION GUIDE

Choose among a large selection of capabilities: Top RF performance and full programmability in the laboratory/bench style of the 2750 Series, and the RF performance and programmability plus portability with the 490 Series; unprecedented measurement convenience in the low-cost portable 2710 Spectrum Analyzer; versatility and high-performance economy in the 7000-Series plug-ins—from baseband through millimeter wave.

Enhance your productivity, measurement repeatability and utility with TekSPANS—the Family of Spectrum Analyzer Applications Software—available for PC compatibles, Tek or HP 200 controllers. Automate your FCC, VDE, and MIL-STD tests with the new EMI prequalification software, and enhance your remote site measurement capabilities with the new Remote Site Monitoring Software.

2750 SERIES LABORATORY SPECTRUM ANALYZERS

Model	Frequency Range	Minimum Resolution	Average Noise Level (Minimum BW)	Amplitude Measurement Range	GPIB Capability	Tracking Generator	Frequency Accuracy	Page	Prices Begin At
New 2753P	100 Hz to 1.8 GHz	10 Hz	−130 dBm	+30 to −130 dBm	Full	TR 503	±[(2% Span or Res BW) +(F x 10^{-9}) +15 Hz] Where: F=Center or Marker Freq	168	$27,250
2754	50 kHz to 21 GHz	1 kHz	−115 dBm	+30 to −115 dBm	Direct Plot	TR 503	±[(20% Span/Div or Res BW) +(Center or Marker Freq) X 10^{-5}] Hz	176	$22,995
2754P	50 kHz to 21 GHz	1 kHz	−115 dBm	+30 to −115 dBm	Full	TR 503		176	$23,995
2755	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 to −125 dBm	Direct Plot	TR 503	[(20% Span/Div or Res BW) +(Center or Marker Freq) X 10^{-5}] Hz	174	$28,500
2755P	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 to −125 dBm	Full	TR 503		174	$30,000
New 2756P	10 kHz to 325 GHz	10 Hz	−134 dBm	+30 to −134 dBm	Full	TR 503	±[(2% Span or Res BW) +(Center or Marker Freq. X 10^{-9}) +(2N + 25 Hz)]	171	$47,995

490 SERIES PORTABLE SPECTRUM ANALYZERS

492A	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 to −125 dBm	Direct Plot	TR 503	±[(20% Span/Div or Res BW) +(Center or Marker Freq X 10^{-5}] Hz	187	$29,040
492AP	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 to −125 dBm	Full	TR 503		187	$30,500
New 494A	10 kHz to 325 GHz	10 Hz	−134 dBm	+30 to −134 dBm	Direct Plot	TR 503	±[(2% Span or Res BW) +(Center or Marker Freq X 10^{-9} +(2N + 25 Hz)]	180	$43,700
New 494AP	10 kHz to 325 GHz	10 Hz	−134 dBm	+30 to −134 dBm	Full	TR 503		180	$47,995
495	100 Hz to 1.8 GHz	10 Hz	−130 dBm	+30 to −130 dBm	Direct Plot	TR 503	±[(2% Span or Res BW) +(F x Ref Error) +15 Hz] Where: F=Center or Marker Freq Ref Error =10^{-5} Standard 10^{-9} Option 05	184	$26,500
495P	100 Hz to 1.8 GHz	10 Hz	−130 dBm	+30 to −130 dBm	Full	TR 503		184	$29,950
496	1 kHz to 1.8 GHz	30 Hz	−126 dBm	+30 to −126 dBm		TR 503	±(5 MHz + 2% Span)	190	$32,950

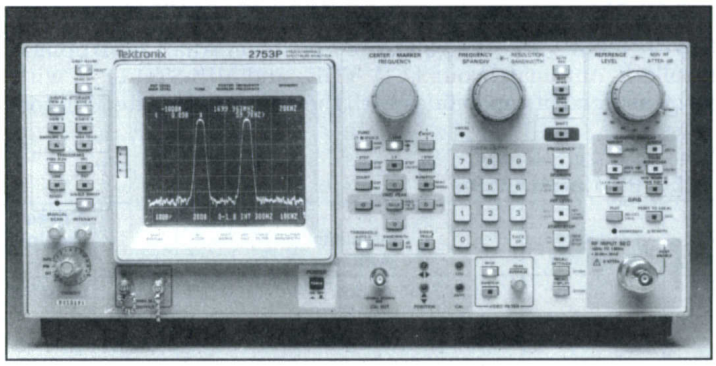
2710 LOW-COST SPECTRUM ANALYZER

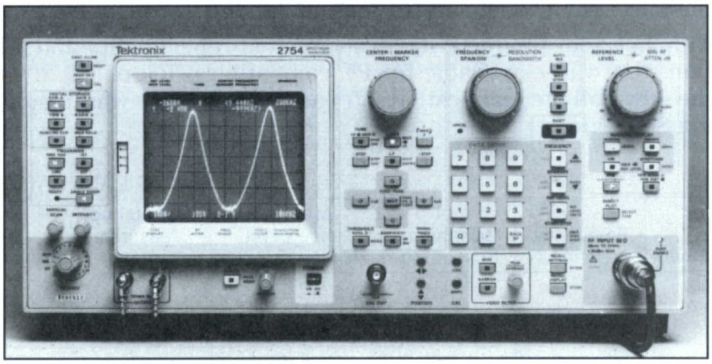
2710	10 kHz to 1.8 GHz	3 kHz	−129 dBm with built-in preamp	+20 to −129 dBm	To be announced	To be announced	CF×10^{-5}±5 kHz CF×10^{-5}±10 kHz (Option 02)	192	$8,250

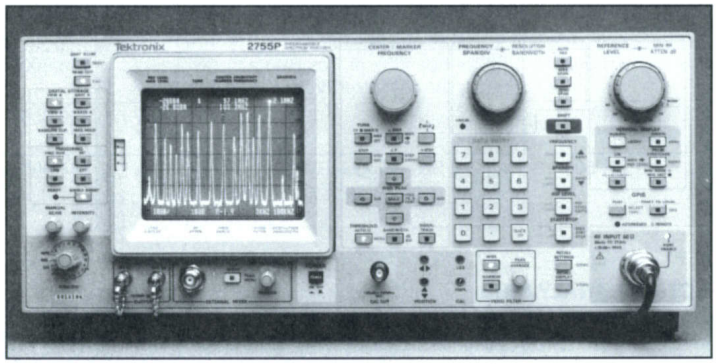
7000 SERIES PLUG-IN SPECTRUM ANALYZERS

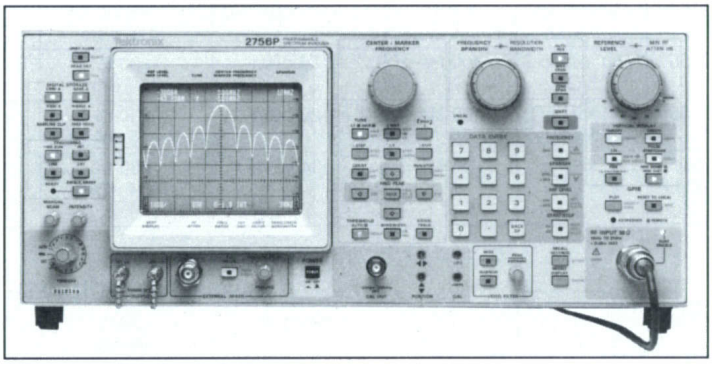
7L5 with L3	10 Hz to 5 MHz	10 Hz	−148 dBV	+8 to −148 dBV	Semi-automatic with 7854	Option 25	±(5 Hz +2 x 10^{-6} Dot Freq)	198	$14,275
7L12	100 kHz to 1.8 GHz	300 Hz	−115 dBm	+30 to −115 dBm	Semi-automatic with 7854	TR 502	±(8 MHz +1% of Dial)	200	$12,500
7L12 Option 39	100 kHz to 2.5 GHz	300 Hz	−115 dBm	+30 to −115 dBm	Semi-automatic with 7854	TR 502 (to 1.8 GHz)	±(8 MHz +1% of Dial)	200	$14,275
7L14	10 kHz to 1.8 GHz	30 Hz	−130 dBm	+30 to −130 dBm	Semi-automatic with 7854	TR 502	±(5 MHz +2% Span)	200	$19,825
7L14 Option 39	1 kHz to 2.5 GHz	30 Hz	−130 dBm	+30 to −130 dBm	Semi-automatic with 7854	TR 502 (to 1.8 GHz)	±(5 MHz +2% Span)	200	$21,600

2750 SERIES SPECTRUM ANALYZERS SETTING NEW STANDARDS FOR LABORATORY PERFORMANCE









- **Frequency Coverage from 100 Hz to 325 GHz**
- **Large, Easy-to-Use, Front-Panel Controls**
- **Built-in Signal Processing/Marker Functions Using Unique Marker Keypad**
- **Many Application-Specific Performance Enhancement Options**

The characteristics of the 2750 Series Laboratory Spectrum Analyzers appear on the following pages. This page contains a selection guide with key electrical characteristics. The following page contains a product matrix by major application area and product matrix for major instrument options. Next are two pages containing common series characteristics, first electrical and then signal processing and marker functions. Lastly, the individual characteristics of each product are listed.

ANCILLARY PRODUCTS

Product	Description/ Feature	Page
TekSPANS	Software	195
WM490 Series	Waveguide Mixers 18 to 325 GHz	191
1405	TV Sideband adaptor	201
TR503	Tracking Generator	201

2750 SERIES LABORATORY SPECTRUM ANALYZERS SUMMARY

Model	Frequency Range	Resolution Range	Average Noise Level (Minimum BW)	Amplitude Measurement Range	GPIB Capability	Display Dynamic Range	Frequency Accuracy	Built-in Counter	Page	Price Begins At
New 2753P	100 Hz to 1.8 GHZ	3 MHz to 10 Hz	−130 dBm	+30 to −130 dBm	Full	90 dB	±[(2% Span or Res BW) +(F×10^{-9}) +15 Hz] Where: F=Center or Marker Freq	Yes	168	$27,250
2754	50 kHz to 21 GHz	1 MHz to 1 kHz	−115 dBm	+30 to −115 dBm	Direct Plot	80 dB	±[(20% Span/Div or Res BW) +(Center or Marker Freq) X 10^{-5}] Hz	No	176	$22,995
2754P	50 kHz to 21 GHz	1 MHz to 1 kHz	−115 dBm	+30 to −115 dBm	Full	80 dB		No	176	$23,995
2755	50 kHz to 325 GHz	1 MHz to 100 Hz	−125 dBm	+30 to −125 dBm	Direct Plot	80 dB	±[(20% Span/Div or Res BW) +(Center or Marker Freq) X 10^{-5}] Hz	No	174	$28,500
2755P	50 kHz to 325 GHz	1 MHz to 100 Hz	−125 dBm	+30 to −125 dBm	Full	80 dB		No	174	$30,000
New 2756P	10 kHz to 325 GHz	3 MHz to 10 Hz	−134 dBm	+30 dBm to −134 dBm	Full	90 dB	±[(2% Span or Res BW) +(Center or Marker Freq. X 10^{-9}) +(2N+25 Hz)]	Yes	171	$47,995

PRODUCT APPLICATIONS

	2753P	2754	2754P	2755	2755P	2756P
Baseband	✓					
CATV		✓ Opt 7				
Satellite Communications		✓ Opt 1	✓ Opt 1	✓ Opt 1	✓ Opt 1	✓
Two-Way Radio	✓					
Broadcasting	✓ Opt 7	✓ Opt 7	✓ Opt 7	✓ Opt 7	✓ Opt 7	✓ Opt 7
Avionics	✓					
EMI/RFI	✓	✓	✓	✓	✓	✓
Terrestrial Microwave		✓ Opt 1, 41	✓ Opt 1, 41	✓ Opt 1, 41	✓ Opt 1, 41	✓ Opt 1
EW	✓ Opt 42	✓ Opt 1, 42	✓ Opt 1, 42	✓ Opt 1, 42	✓ Opt 1, 42	✓ Opt 42
Millimeter Wave				✓ Opt 21, 22	✓ Opt 21, 22	✓ Opt 21, 22
ATE	✓ MATE Opt 45		✓ MATE Opt 45		✓ MATE Opt 45	✓ MATE Opt 45
LAN	✓ Opt 7	✓ Opt 7	✓ Opt 7			

✓ = Recommended product.
Opt = Recommended options.

PRODUCT OPTIONS

	2753P	2754	2754P	2755	2755P	2756P
Option 1		✓	✓	✓	✓	S
Option 7	✓	✓	✓	✓	✓	✓
Option 21				✓	✓	✓
Option 22				✓	✓	✓
Option 23*1	✓		✓		✓	✓
Option 24*1	✓		✓		✓	✓
Option 25*1	✓		✓		✓	✓
Option 26*1	✓		✓		✓	✓
Option 28*1	✓		✓		✓	✓
Option 29	✓		✓		✓	✓
Option 30	✓	✓	✓	✓	✓	✓
Option 31	✓	✓	✓	✓	✓	✓
Option 39	✓	✓	✓	✓	✓	✓
Option 41		✓	✓	✓	✓	✓
Option 42	✓	✓	✓	✓	✓	✓
Option 45	✓		✓			✓
Option M1	✓	✓	✓	✓	✓	✓
Option M2	✓	✓	✓	✓	✓	✓
Option M3	✓	✓	✓	✓	✓	✓

✓ = Option available.
S = Included with standard product.
**1 Options 24, 25, 26, 28, and 29 are bundled software/computer packages available only in the U.S. Contact your local sales representative.*

OPTION DESCRIPTION

Option 01—Adds preselection for the 1.7 to 21 GHz band and limiter for 1st mixer below 1.8 GHz.
Option 07—75 Ω dBmV input and calibration in addition to 50 Ω dBm input and calibration.
Includes: BNC male-to-female adaptor connector (013-0126-00); 42-inch, BNC-to-BNC connector, 75 Ω coax cable (012-0074-00).
Option 21—High Performance 18- to 40-GHz Waveguide Mixer Set includes two mixers (18 to 26.5 GHz, and 26.5 GHz to 40 GHz).
Includes: Diplexer assembly (015-0385-00).
Option 22—High Performance 18- to 60-GHz Waveguide Mixer Set includes three mixers (18 to 26.5 GHz, 26.5 to 40 GHz, 40 to 60 GHz).
Includes: Same as Option 21.
Option 23—GRASP and GPIB Interface.
Includes: GRASP software, National's PC2A (GPIB) card, and GPIB cable.
Option 24*1 —Portable II, Model 2.
Includes: GRASP, PC2A, GPIB cable, Compaq Portable II (Model 2), 80286 processor, 256K byte RAM, 2 each 360K-byte floppy drives, built-in monitor, and serial/parallel interface.
Option 25*1 —Deskpro, Model 2.
Includes: GRASP, PC2A, GPIB cable, Compaq Deskpro (Model 2), 8086 processor, 256K byte RAM, 2 each 360K-byte floppy drives, enhanced color display, and serial/parallel interface.
Option 26*1 —Deskpro 286, Model 1.
Includes: GRASP, PC2A, GPIB cable, Compaq Deskpro 286 (Model 1), 80286 processor, 256K byte RAM, 1.2M-byte/360K-byte floppy drives, enhanced color display, and serial/parallel interface.
Option 28*1 —Deskpro 286, Model 20.
Includes: GRASP, PC2A, GPIB cable, Compaq Deskpro 286 (Model 20), 80286 processor, 640K byte RAM, 20M-byte hard drive, 1.2M-byte/360K-byte floppy drives, enhanced color display, and serial/parallel interface.
Option 29*1 —Epson printer.
Includes: Epson FX-86E printer and parallel interface cable.
Option 30—Rackmount 19-in. rack width.
Includes: Rack slides (351-0623-00).
Option 31—Rackmount 19-in. rack width with rear panel input/output capability (no front panel inputs).
Includes: Same as Option 30.
Option 39—Non-Lithium (Silver) batteries for battery-powered memory.
Option 41—Digital Microwave Radio Enhancement.
Includes: Wider bandwidth preselector for better signal symmetry in digital radio bands; Narrow video filter (approximate 1/3000th resolution bandwidth); Improved frequency span/div accuracy at 5-MHz/div span.
Option 42—Replaces MARKER/VIDEO input port on the rear panel with a 110 MHz IF output port which provides a signal with a 3 dB bandwidth ≥5 MHz and makes the 2755 suitable for broadband, swept-receiver measurements.
Option 45—(2750P) MATE/CIIL language.
Option 52—North American 220 V configuration with standard power cord. Fuses are replaced with 2 A slo-blo.
**1 Options 24, 25, 26, 28, and 29 are bundled software and computer packages and are available in the U.S. only. For more information, contact your local sales representative.*

2750 SERIES COMMON CHARACTERISTICS

The following characteristics are common to the 2750 Series.

AMPLITUDE RELATED

Vertical Display Modes—10 dB/div, 2 dB/div and linear via pushbutton; any integer from 1 to 15 dB/div via Data Entry keypad.

Reference Level Steps—10 dB coarse, 1 dB fine in 10 dB log; 1 dB coarse, 0.25 dB fine in 2 dB log. 1-2-5 sequence coarse, 1 dB equivalent fine in linear; coarse step = log/div, fine is 1 dB for 5 dB/div or greater, 0.25 dB for 4 dB/div or less set via Data Entry keypad.

Reference Level Accuracy—Accuracy is dependent on a combination of RF Attenuator Accuracy, IF Gain Accuracy, Resolution Bandwidth, Display Mode, Calibrator Accuracy, Frequency Band, Frequency Response and Temperature Change (±0.15 dB/°C maximum).

Display Amplitude Accuracy—±1.0 dB/10 dB to a maximum of ±2 dB over 80 dB ±4 dB over 90 dB for the 2756P/2753P (12 dB Log); ±0.4 dB/2 dB to a maximum of ±1.0 dB over 16 dB (2 dB Log); ±5% of full scale in linear mode.

RF Attenuator Range—0 to 60 dB in 10 dB steps.

Attenuator Accuracy—DC to 1.8 GHz: 0.5 dB/10 dB, 1 dB maximum cumulative error over 60 dB. 1.8 to 18 GHz: 1.5 dB/10 dB, 3 dB maximum cumulative error over 60 dB. 18 to 21 GHz: 3 dB/10 dB, 6 dB maximum cumulative error over 60 dB.

Resolution Bandwidth Gain Variation—±0.4 dB (after CAL with respect to 1 MHz filter).

IF Gain Range—87 dB increase; 10 dB decrease in MIN NOISE, 20 dB with MIN NOISE and Reduced Gain Mode; 10 dB and 1 dB steps.

IF Gain Accuracy—≤0.2 dB/dB to maximum of 0.5 dB/9 dB except at the decade transitions: −19 to −20 dBm, −29 to −30 dBm; −39 to −40 dBm, −49 to −50 dBm, −59 to −60 dBm. An additional ≤0.5 dB for a maximum cumulative error of 1 dB over 10 dB; ±2 dB maximum deviation over the 97 dB range.

Marker/s Accuracy—Equal to Reference Level Accuracy plus Display Amplitude Accuracy.

Third Order Intermodulation Distortion—(Option 01 only) ≤ −70 dBc for CW signal (MIN Distortion Mode) Any two on-screen signals within any frequency span (50 kHz to 21 GHz); ≤ −100 dBc for signals spaced ≥100 MHz for preselector bands.

LO Emissions—≤ −10 dBm. With Preselector: ≤ −70 dBm.

Spurious Responses (Residual)—≤ −100 dBm.

DISPLAY CHARACTERISTICS

CRT—8×10 cm, GH (P31) Phosphor.

CRT Readout—Displays: Reference level, center frequency, marker frequency and amplitude, frequency range, vertical display mode, frequency Span/Div, resolution bandwidth, RF attenuation, video filter, and text.

Video Filter Range—0.3 Hz to 30 kHz (coupled to resolution filter by front-panel pushbuttons).

Sweep—Triggered, auto, manual, single sweep, and external.

Sweep Time—2 μs to 5 s/div (10 s/div in auto) in a 1-2-5 sequence; accuracy ±5%.

Triggering—Internal, External, Line, and Free Run; internal trigger level ≥2 divisions of signal; external level ≥1 V peak, 15 Hz to 1 MHz, 50 V maximum (dc + ac peak).

Digital Storage—1000 points horizontal, 250 points vertical; A and B Views; Save A; Max Hold; B-Save A; digital averaging (peak/average); Pulse Stretcher.

Nonvolatile Display Memory—Store and recall up to nine full waveforms complete with CRT readouts.

OUTPUT SIGNAL

Calibrator (Cal Out)—−20 dBm ±0.3 dB at 100 MHz ±REF Error.

1st and 2nd LO—Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm, 2nd LO −22 dBm minimum to maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

Vertical Out—Provides 0.5 V ±5% of signal per division of video above and below the centerline.

Horizontal Out—Provides 0.5 V either side of center. Full range −2.5 to +2.5 V ±10%.

Pen Lift—TTL, 5 V nominal to lift pen.

IF Out—Output of the 10 MHz IF. Level is approximately −5 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

110 MHz IF Output—(Option 42) Center frequency from 108.5 to 111.5 MHz; 3 dB bandwidth >5 MHz; bandpass ripple ≤0.5 dB; power out with −30 dBm reference level and a full screen signal ≤0 dBm; 1 dB compression at ≥0 dBm output, MIN DISTORTION: 50 Ω nominal impedance.

Probe Power—Provides operating voltages for active probes.

Pin 1	+5 V at 100 mA maximum
Pin 2	Ground
Pin 3	−15 V at 100 mA maximum
Pin 4	+15 V at 100 mA maximum

INPUT SIGNAL

Horizontal/Trigger Input—Rear-panel BNC female. Horizontal: DC coupled input, 0 to +10 V (dc + peak ac), for full screen sweep, selected in the EXT position of the TIME/DIV control. Trigger: AC coupled, 1.0 to 50 V (dc + peak ac), 15 Hz to 1 MHz, 30 V_{rms} at 100 kHz and above; pulsewidth ≥0.1 μs.

Marker/Video Input—External Marker or video input switched by pin 1 of the accessories connector (J104). Video input 0 to +4 V. Marker input 0 to −10 V (interfaces with Tektronix 1405 Sideband adaptor).

IEEE STANDARD 488 (GPIB) CHARACTERISTICS

P Version—In accordance with IEEE Standard 488-1978 implemented as SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, and C0.

Non-P Versions (Plotter Output)—Implemented as SH1, AH0, T3, L0, SR0, RL0, PP0, DC0, DT0, and C0.

GENERAL CHARACTERISTICS

Battery-Powered Memory—Nine instrument settings plus power-down settings, Nine full waveforms plus readouts. Eight macros, frequency and amplitude calibration factors, 39 preselector peaks and 12 external band peaks are stored in nonvolatile RAM. Battery life ≥5 years at 25°C, >1 year at 55°C.

Power—210 W max with all options, at 115 V and 60 Hz.

Input Voltage—90 to 132 V ac, 48 to 448 Hz, or 180 to 250 V ac, 48 to 72 Hz.

Configuration—Bench/Rackmount. 177.8×431.8×609.6 (7×17×24 in.).

ENVIRONMENTAL

Per MIL-T-28800C Type III, Class 5, Style E.

Temperature—Operating: 0 to +50°C. Nonoperating: −40 to +75°C.

Humidity—95% below +30°C, 75% above +30°C, 45% above +40°C.

Altitude—Operating: 10,000 feet. Nonoperating: 40,000 feet.

Electromagnetic Compatibility—The 2750/P Series Spectrum Analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources with the exceptions shown below.

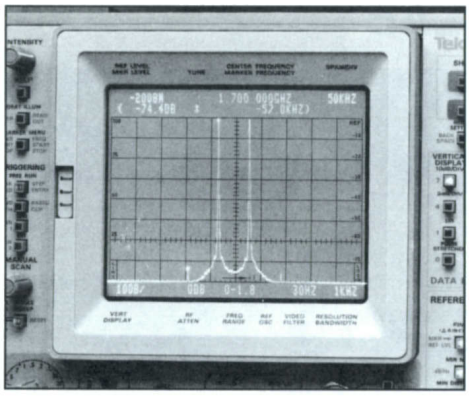
Conducted Emissions—CE01: 15 dB relaxation for first 10 harmonics of power line frequency. CE03 (Narrowband): Full limits. CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility—CS01: Full limits. CS02: Full limits. CS06: Full limits.

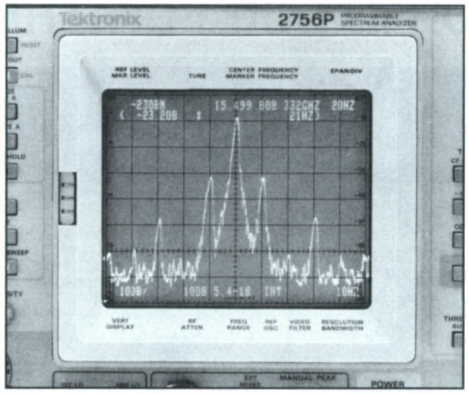
Radiated Emissions—RE01: 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 to 36 kHz. RE02: Full limits.

Radiated Susceptibility—RS01: Full limits. RS02-1: Full limits. RS02-2: To 5 amps only. RS03: Up to 1 GHz only.

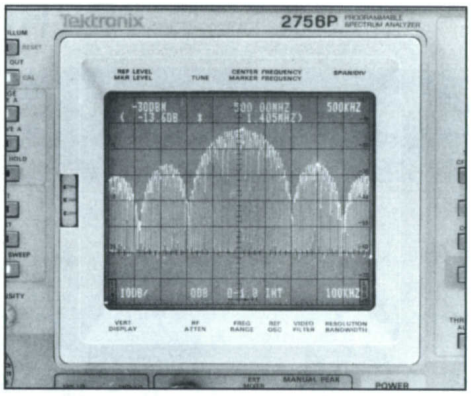
SUMMARY OF SIGNAL PROCESSING AND MARKER FUNCTIONS



Intermodulation measurement using alternate CRT.



Close-in sidebands using 10 Hz Resolution Bandwidth.



Marker measurement on Pulsed RF using Pulsed Signal processing mode.

Marker Key Pad Functions

PEAK FIND: Locates and marks the highest displayed signal on the CRT.

RIGHT NEXT: Moves marker to the right next signal defined by "SIGNAL TYPE" in frequency.

LEFT NEXT: Moves marker to the left next signal defined by "SIGNAL TYPE" in frequency.

NEXT LOWER: Moves marker to the next lower signal defined by "SIGNAL TYPE" in amplitude.

NEXT HIGHER: Moves marker to the next higher signal defined by "SIGNAL TYPE" in amplitude.

MOVE RIGHT "X" dB: Moves marker to the right "X" dB (X can be + or −) in signal amplitude from its current position.

MOVE LEFT "X" dB: Moves marker to the left "X" dB (X can be + or −) in signal amplitude from its current position.

FIND PEAK AND CENTER: Marks the highest displayed signal and moves it to the center of the CRT screen.

Signal Type Menu

Sets the signal processor pattern recognition from a selection of three routines. Chosen signal type remains in memory until overwritten by new selection, RESET (which defaults to CW), or power down:

CW: Recognizes signals with CW characteristics—ignores all others (instrument selects this mode at power-up).

PULSE: Recognizes pulsed RF lobe patterns for line and dense spectrums—places marker at peaks—easy location of carrier spectral line.

SPUR: Recognizes *ALL* signals including impulses above the assigned Threshold.

Noise Normalization (dB/Hz): Normalizes the noise measured at the marked position to one Hertz—Simplifies Phase Noise and Signal/Noise Ratio tests.

Signal Track: Locates, marks, and centers on the highest signal on screen above the Threshold. If track is lost, or if the signal drops below Threshold value, "SIGNAL TRACK IDLE" will be displayed on the CRT below the last "tracked" frequency and the instrument will "idle" there until track is regained.

Bandwidth: Places the markers the assigned number (from memory) of dB below, left, and right of the desired signal peak automatically after each sweep.

Marker to Reference Level: Changes reference level to the marker amplitude value.

Marker to Center: Changes center frequency to equal marker frequency.

Marker Start/Stop: Frequency start/stop sweep is matched to the current Δ marker position.

Step Size: Assigns either the center, marker, or Δ marker frequency to the ± STEP frequency functions.

Macro Menu (2756P and 2753P only): Allows the selection from up to seven stored user-defined programs to be executed.

Run/Stop (2756P and 2753P only): Starts and stops execution of the selected Macro program.

Settings Store/Recall: Allows up to nine full front-panel set-ups, plus a power-down last instrument state, to be stored and recalled from nonvolatile memory.

Zoom (IEEE-488 function only): Moves the marked signal to center screen and decrements the span.

Built-in Microwave Counters

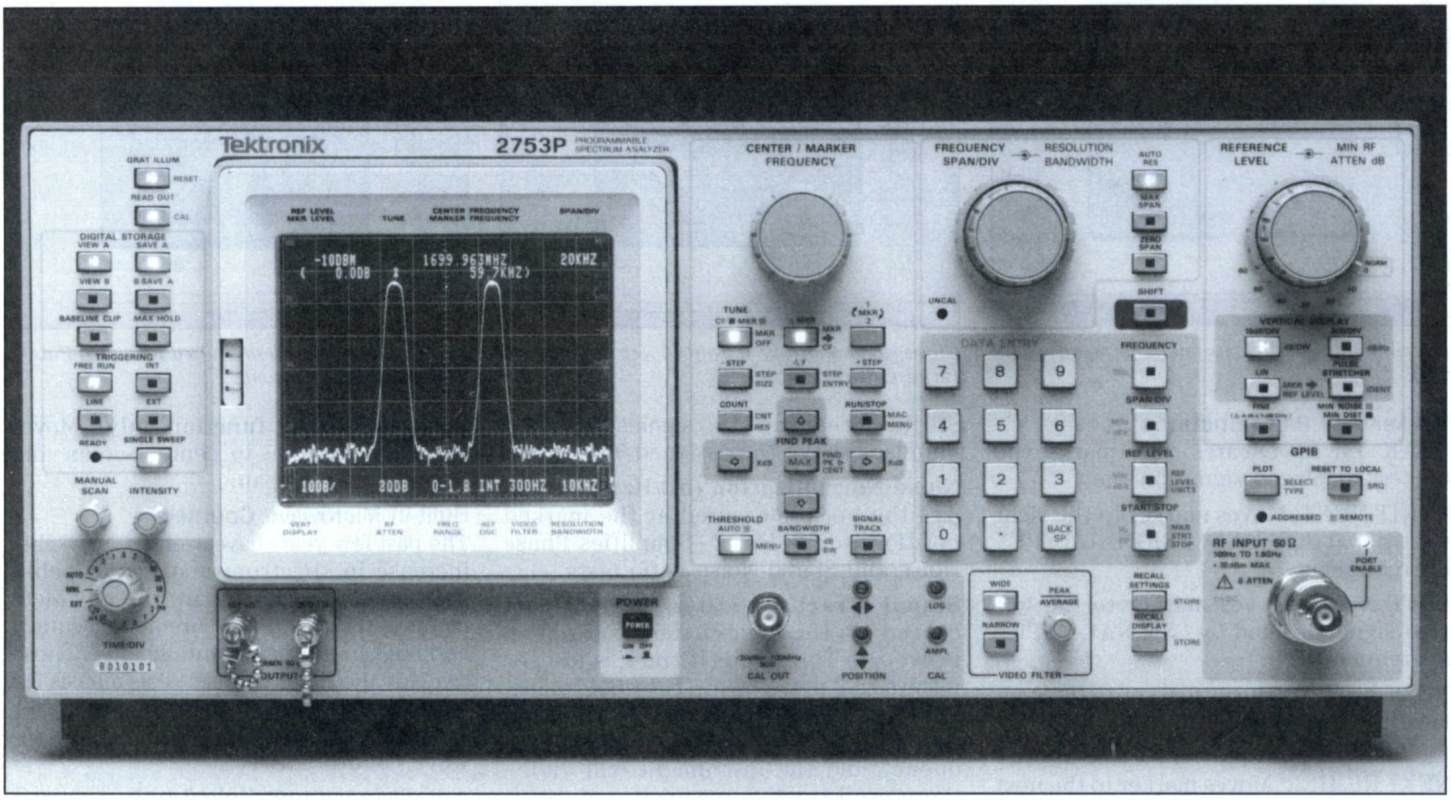
The past few years have seen a remarkable increase in spectrum analyzer capabilities. Most noteworthy are the advancements in frequency measurement accuracy and built-in processing intelligence. These two advances, in turn, serve as a basis for a third noteworthy spectrum analyzer advance—the addition of built-in microwave counters.

A built-in counter linked to a spectrum analyzer marker system offers several unique measurement capabilities versus those of stand-alone general-purpose counters. These spectrum analyzer counter capabilities include:

- Orders of magnitude better sensitivity, to −104 dBm for example, for low amplitude signal measurement.
- High selectivity for measuring desired signals in multi-signal environment (e.g., one satellite transponder out of a group of transponders).
- Wider frequency range (e.g., 100 Hz to 325 GHz), and
- The ability to view the spectrum and the actual signal being counted.

The ability to see and select what is being counted offers substantial advantages over the "blind" operation of stand-alone counters. Two of the 2750-series spectrum analyzers have built-in frequency counters—the 2756P and 2753P. For more information on how a built-in counter can benefit you, contact your local Tektronix office.

SETTING STANDARDS FOR VHF/UHF PERFORMANCE FOR THE LAB



NEW 2753P

GPIB IEEE-488 The 2753P complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Covers 100 Hz to 1.8 GHz, with −130 dBm Sensitivity and ±1.0 dB Frequency Response**
- **Up to 10^{-9} Marker and Center Frequency Accuracy, Built-in Signal Counter, External Reference Input**
- **10 Hz to 3 MHz Resolution Bandwidth**
- **Front-Panel Execution of Down-Loaded Programs**
- **Intelligent Markers with Signal Processing Functions**
- **Large Easy-to-Use Controls**
- **Dedicated Keypad Entry of Control Parameters**
- **Pushbutton Occupied Bandwidth and Noise Normalization Functions**
- **Switch Selectable 50 and 75 Ω Impedances (Option 07) for IF, CATV and Local Area Network Applications**
- **Nonvolatile Memory for up to Nine Waveforms and Ten Front-Panel Settings**
- **Optional MATE/CIIL Compatibility**
- **Plot Data Directly Without a Controller**
- **Superior Rack Profile**

A New Benchmark in Laboratory Spectrum Analysis. Standalone or Automated, Baseband through UHF

The Tektronix 2753P offers exclusive signal processing capabilities and outstanding ease of use in a spectrum analyzer package you can tailor to your needs. Offering frequency coverage from 100 Hz to 1.8 GHz with an impressive −131 dBm sensitivity, the 2753P is optimized for VHF/UHF measurements, where ability to identify and process weak signals is critical.

Macro Programming, 10^{-9} Frequency Accuracy, Signal Counting and System Clock Compatibility

Downloadable programming capability lets you execute frequently used measurement routines from the spectrum analyzer's nonvolatile memory. An internal high stability reference provides 10^{-9} marker or center frequency accuracy for added confidence in measurements. In addition, the flexibility of tying in with a system clock by using the instrument's external reference lock capability provides for even greater frequency accuracy. A built-in signal counter with 140 dB dynamic range means you can determine the exact frequency of marked signals only 10 Hz apart—or count the exact Δfrequency between two marked signals—even with greatly differing amplitudes.

Menu-selected, Intelligent Markers and Signal Processing

Dynamic markers automatically update frequency and amplitude data with every sweep. When used in conjunction with the 2753P's powerful signal processing intelligence, you can use PULSE Mode to mark the peak of a main lobe and peaks of side lobes at the push of a button. CW mode locates signals exhibiting CW characteristics and ignores all other signals. SPUR mode marks all signals that meet user-definable or automatic threshold criteria. Threshold criteria are available for all signal processing modes.

The 2753P also offers hands-off convenience for measuring the bandwidths of filters, amplifiers, and other networks. Simply enter the desired bandwidth point, select BANDWIDTH mode and markers automatically update to display the new value.

Nonvolatile memory lets you store up to ten front panel settings and nine waveforms, simplifying setup and making

measurements faster and easier. A permanent record of CRT displays can be obtained at the push of a button, without a controller, using the direct plot capability.

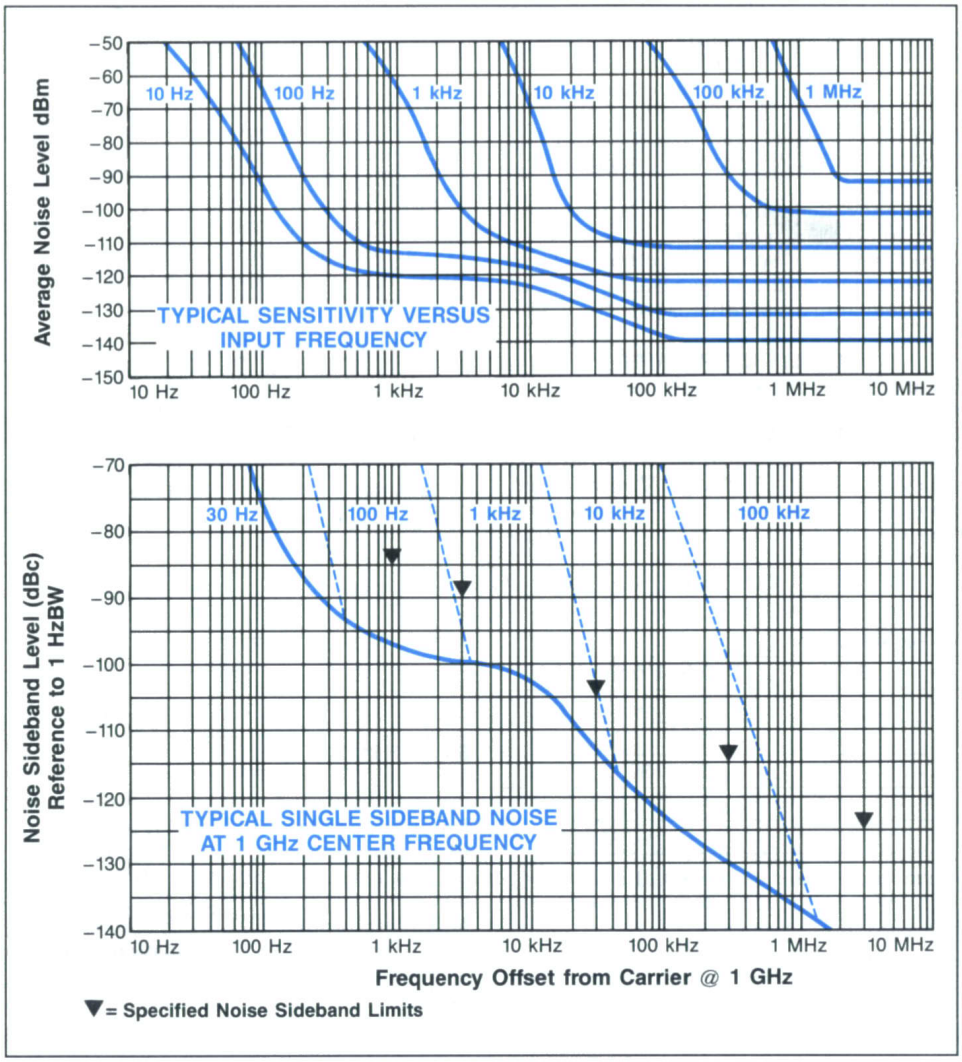
Dedicated Direct Keypad Data Entry of Major Measurement Parameters
Enables fast, accurate instrument setup—user is prompted by screen messages for proper keypad inputs—all "valid" keys to push are illuminated to steer users to proper selections. Unique marker keypad allows for Peak Find, Right and Left Next, Next Higher and Lower, Left and Right ×dB, and Peak Find and Center to be executed direct from the front panel. This makes signal searches much easier.

Switch Selectable 50 and 75 Ω Impedances (Option 07) Add Versatility
For applications such as CATV measurements, 75 Ω/dBmV greatly simplifies spectrum analysis. You no longer need to manually convert dBm to dBmV units or make measurement adjustments for external 50 to 75 Ω transformers. Option 07 also provides a 300 kHz resolution bandwidth filter optimized for VHF/UHF measurements.

The GPIB-Programmable 2753P is a Valuable Systems Component
It increases speed and ensures measurement repeatability with fully automated spectrum analysis for small ATE or large-system needs. Under program control you can change front-panel settings, read data from the CRT display, and send waveforms from internal digital source memory to other GPIB devices. Tek's Standard Codes and Formats keep commands clear, consistent and universally understood.

Tektronix Automated Spectrum Analyzer Packages
Convenient to order, these packages are configured around Compaq's PC and Tek's programmable 2750P Series Spectrum Analyzers. Coupling the PC to analyzer via the IEEE-488 bus enables the user to take advantage of the PC's capability, as well as the power and versatility of Tek spectrum analyzers. A highly versatile General RF Applications Software Package (GRASP) offers many different applications and utility routines which are selected through easy, menu-driven operation. Also, EMI Software is available for FCC, VDE, CISPR, and MIL-STD testing.

The 2753P offers many other time-saving and accuracy-enhancing capabilities too numerous to cover here. See the summary of signal processing and marker functions on page 167 for additional information on measurement benefits. Complete details are available from your Tektronix Spectrum Analyzer Sales Engineer.



CHARACTERISTICS

The following characteristics apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Center and Marker Frequency Accuracy—±[20%D + (F × Ref Freq Error) +15 Hz] with Span/Div ≤200 kHz (phase locked); ±20%D +(F × Ref Freq Error) +15 kHz] with Span/Div >200 kHz (unlocked).
Where: D=Span/Div or Resolution BW, whichever is greater.
F=Center or Marker Frequency.

Reference Frequency Error (Internal)—≤1 $\times 10^{-9}$ per day; $\leq 1\times 10^{-7}$ in the first six months, $\leq 1\times 10^{-7}$ per year thereafter; accuracy 30 minutes after power on within 5×10^{-8} of the frequency after 24 hours; within 2×10^{-8} over the temperature range of −15 to +55 °C.

Signal Counter Accuracy—± [(F × Ref Freq Error) + 12 Hz + 1 LSD]
Where: F=Center, Marker or Δ Marker Frequency
LSD=Least Significant Digit

Counter Sensitivity—Signal level must be ≥20 dB above the average noise level and within 60 dB of the reference level.

Counter Readout Resolution—Selectable from 1 Hz to 100 MHz in decade steps.

External Reference Input—Frequency: 1, 2, 5, or 10 MHz with ≤5 ppm stability.
Power Range: −15 to +15 dBm.
Waveshape: Sine wave, ECL, TTL (allowable duty cycle symmetry is 40% to 60%).
Input Impedance: 50 Ω ac, 500 Ω dc; rear-panel BNC input.

Delta Marker Frequency Accuracy—±1% of total span.

Frequency Drift (after 1-hour warm-up)—Span/Div ≤200 kHz (phase locked): Drift rate ≤50 Hz/min. Correction will occur at the end of sweep for sweep times ≥5 s/div. (Drift rate is typically <20 Hz/min after 1-hour warm-up from 25 °C storage.)
Span/Div >200 kHz (unlocked): Drift rate typically <25 kHz/min (typically <25 kHz/min) after 30-minute warm-up).

Frequency Readout Resolution—≤10% of Span/Div to 1 Hz minimum.

Residual FM—≤5 Hz peak-to-peak in 20 msec, Span/Div ≤200 kHz (phase locked); ≤7 kHz peak-to-peak in 20 msec, Span/Div >200 kHz (unlocked).

Resolution Filters—10 Hz to 3 MHz; 10 Hz to 1 MHz in decade steps; 6 dB bandwidth ±20%; Shape factor ≤7.5:1 except 10 Hz where 60 dB BW ≤150 Hz.

Frequency Span/Division—0 Hz (ZERO SPAN pushbutton or keypad data entry); 10 Hz to 100 MHz (in a 1-2-5 sequence) via Span/Div knob; 10 Hz to 170 MHz (to two significant digits) via FREQUENCY or MARKER START/STOP, or Data Entry keypad; 180 MHz via power-up, RESET, or MAX SPAN pushbuttons; accuracy ±5%.
Frequency Response—±1.0 dB (measured with 10 dB RF attenuation).
Zero Frequency Spur—−24 dBm maximum measured into 50 Ω and open circuit with 0 dB RF attenuation; −35 dBm typical.

AMPLITUDE RELATED

Display Dynamic Range—90 dB LOG mode; 8 divisions LINEAR mode.
Reference Level Range—
LOG Mode: −117 to +40 dBm (+30 dBm maximum); −130 to +27 dBV (+77 dBmV maximum); −70 to +87 dBmV (+77 dBmV maximum); −10 to +147 dBμV (+137 dBμV maximum).
LINEAR Mode: 39.6 nV/Div to 2.8 V/Div (1 watt or 10 V peak maximum).

Noise Sidebands

dBc/Hz	Offset from Carrier
−80	300 Hz
−90	3 kHz
−105	30 kHz
−115	300 kHz
−125	3 MHz

Harmonic Distortion—≤60 dBc for a −30 dBm CW signal with 0 dB RF attenuation in MIN DISTORTION mode.

Sensitivity (Equivalent Input Noise)

Sensitivity dBm	Resolution Bandwidth
−131	10 Hz
−125	100 Hz
−115	1 kHz
−105	10 kHz
−95	100 kHz
−85	1 MHz
−80	3 MHz

INPUT CHARACTERISTICS

RF Input—Type "N" female, 50 Ω nominal impedance.
VSWR—1.3:1 maximum, 1.2:1 typical, with 10 dB or more RF attenuation; 2.0:1 maximum, 1.9:1 typical, with 0 dB RF attenuation.
Maximum Safe Input (0 dB RF attenuation)—+30 dBm (1 W) continuous, 75 W peak, 1 μsec pulsewidth, 0.001 duty; 0 V dc.
1 dB Gain Compression—−10 dBm with 0 dB RF attenuation in MIN NOISE; −20 dBm with 0 dB RF attenuation in MIN DISTORTION; (No gain compression can be observed on screen).

CHARACTERISTICS

50/75 Ω OPTION 07
75 Ω INPUT RELATED

Provides 75 Ω input and dBmV calibration in addition to the normal 50 Ω input and dBm calibration. The 100 kHz resolution filter is replaced by 300 kHz to optimize the instrument for broadcast and CATV uses.
Center Frequency Range—1 to 1000 MHz.
Frequency Response—±2.0 dB from 5 to 1000 MHz; typical response for the 1 to 5 MHz frequency range is <3 dB down from the 5 MHz response.
Reference Level Range—−68 to +79 dBmV (+89 dBmV is achievable in MIN NOISE mode).

Sensitivity (Equivalent Input Noise): 5 to 1000 MHz—75 Ω Input

Sensitivity dBmV	Resolution Bandwidth
−81	10 Hz
−76	100 Hz
−66	1 kHz
−56	10 kHz
−41	300 kHz
−36	1 MHz
−31	3 MHz
50 Ω RF Input	
−90 (dBm)	300 kHz

Input Impedance—75 Ω; VSWR 1.35:1 (17 dB RL) maximum, 5 to 800 MHz; VSWR 1.6:1 (13 dB RL) maximum, 800 to 1000 MHz; BNC female.
Maximum Input Level—With 0 dB attenuation: +78 dBmV. With attenuation >20 dB: +78 dBmV, 100 V maximum (dc + ac peak).
Calibrator (Cal Out)—+20 dBmV ±0.5 dB; 75 Ω impedance nominal.

ORDERING INFORMATION

2753P Programmable Spectrum Analyzer **$27,250**
Includes: 6 ft, N to N connector, 50 Ω coax cable (012-0114-00); 18-in., BNC-to-BNC connector, 50-Ω coax cable (012-0076-00); N male-to-BNC female adaptor (103-0045-00); 4-A fast-blow fuses (159-0017-00); power cord (161-0104-00); power cord clamp (343-0170-00); amber CRT light filter (378-0115-01); gray CRT light filter (343-0115-02); CRT mesh filter (378-0227-01); rear connector shield (337-3274-00); operator's manual (070-6305-00); programmer's manual (070-6308-00).

OPTIONS

Option 07—75 Ω input. **+$750**
Includes: BNC male to female adaptor connector (013-0126-00); 42-in. BNC to BNC connector 75 Ω coax cable (012-0074-00).
Options 23, 24, 25, 26, 28, 29—Bundled software and computer packages available in U.S. only. Contact your local sales representative.
Option 30—Rackmount. **+$250**
Option 31—Rackmount with rear-panel input/output connectors. **+$450**
Option 39—Replaces Lithium with Silver batteries for instrument memory. **+$50**
Option 42—110 MHz, >5 MHz bandwidth, IF Output suitable for broadband receiver measurements. **+$1,500**
Option 43—Alternate CRT. **+$250**
Option 45—MATE/CIIL language interface. **+$4,975**
Option 52*1—North American 220 V configuration with standard power cord.
Option B1—Service manuals (Vol. 1) 070-6306-00. (Vol. 2) 070-6307-00. **+$50**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Service section.
Option M1—2 Calibrations. **+$1,810**
Option M2—2 Years Service. **+$3,015**
Option M3—2 Years Service and 4 Calibrations. **+$3,620**

*1 *To order contact your local Tektronix Sales Office.*

OPTIONAL ACCESSORIES

TR 503 Tracking Generator—For more information see page 201. **$7,080**
75 to 50 Ω Power Splitter—Order 067-1232-00. **$250**
75 to 50 Ω Minimum Loss Attenuator—Order 011-0112-00. **$60**
DC Block N to N—Order 015-0509-00. **$250**
P6201 FET Probe to 900 MHz. **$1,250**
1405 TV Sideband adaptor—525/60 Markers. See page 201. **$5,780**
Camera—C-5C. **$495**

Note: 2750-Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52, and C-53 cameras.

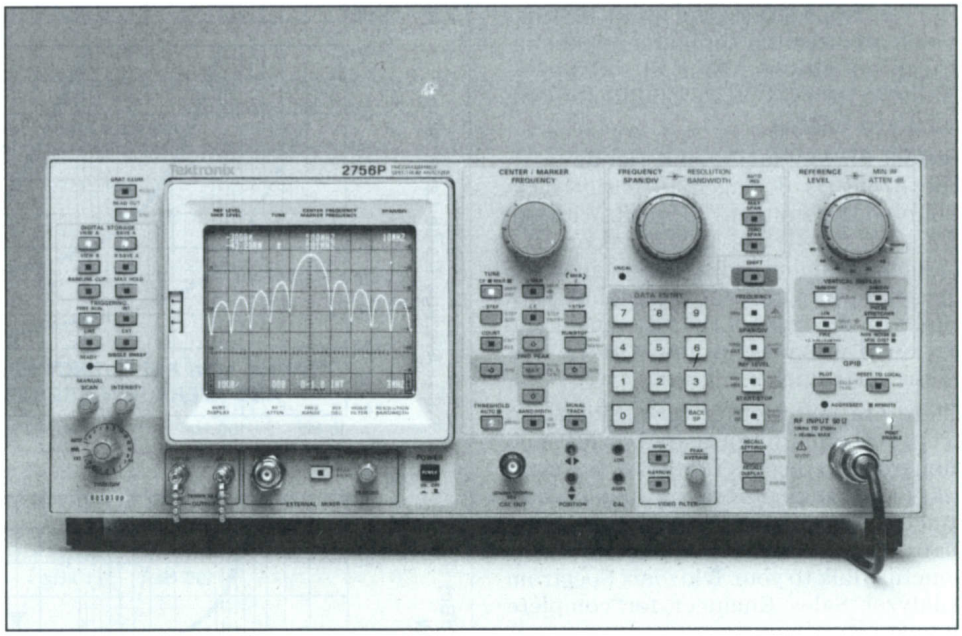
See page 202 for additional accessories.

NEW 2756P

GPIB IEEE-488 The 2756P complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Covers 10 kHz to 325 GHz, −134 dBm Sensitivity, and 10 Hz to 3 MHz Resolution**
- **90 dB Display Dynamic Range**
- **Built-in High Performance Microwave Frequency Counter**
- **Excellent Marker and Center Frequency Accuracy (up to 10^{-9}) and External Reference Input for Locking to a System Clock**
- **Macro Programming Saves Frequently Used Measurement Programs in Nonvolatile Instrument Memory**
- **Intelligent Markers with Signal Processing Functions Using Unique Marker Keypad**
- **Dedicated Data Keypad for Entry of Key-Control Parameters**
- **Large, Easy-to-Use Controls**
- **Internal Preselection**
- **Push-button Occupied Bandwidth and Noise Normalization Functions**
- **Nonvolatile Memory for up to Nine Waveforms and Ten Front-Panel Settings**
- **Plot Data Directly Without a Controller**
- **Fully GPIB Programmable**
- **Optional MATE/CIIL Compatibility**

TOP-OF-THE-LINE PERFORMANCE AT AN AFFORDABLE PRICE



Lab Performance at an Affordable Price

The Tektronix 2756P Spectrum Analyzer offers features essential for laboratory measurements. Offering frequency coverage from 10 kHz to 325 GHz, the 2756P has impressive −134 dBm sensitivity and advanced, intelligent markers with exclusive signal processing capabilities. The 2756P is optimized for use in baseband through millimeter wave measurements, where ability to identify and process signal frequencies and amplitudes over wide dynamic ranges with high accuracy is critical.

Let the 2756P Make the Measurements

Downloadable programming capability lets you execute your frequently used measurement routines from the spectrum analyzer's nonvolatile memory. Tedious and often incorrect conversions from dBm to dBmV, dBV, dBμV, or dB/Hz reference units are no longer required since the 2756P handles it all for you. In addition, the 2756P can store up to ten complete instrument set-ups in nonvolatile RAM for recall at the touch of a few buttons.

An internal high stability reference provides marker or center frequency accuracy approaching 10^{-9} for added confidence in measurements. A built-in microwave signal counter with 144 dB dynamic range means you can determine the exact frequency of marked signals only 10 Hz apart—or count the exact delta frequency between two marked signals—even with greatly differing amplitudes. You also have the flexibility of tying in with a system clock, using the instrument's external reference lock capacity.

A permanent record of CRT displays can be obtained at the push of a button, without a controller, using the direct plot capability.

Intelligent Markers Utilize Advanced Signal Processing

New dynamic markers automatically update frequency and amplitude data with every sweep. When used in conjunction with the 2756P's powerful signal processing intelligence you can use PULSE mode to mark the peak of a main lobe and peaks of side lobes at the push of a button. CW mode locates signals exhibiting CW characteristics and ignores all other signals. SPUR mode marks all signals that meet user-defined or automatic threshold criteria. User-definable threshold criteria are available for all signal processing modes.

The 2756P also offers operator convenience for measuring the bandwidth filters, amplifiers and other networks. Simply enter the desired bandwidth point, select Bandwidth mode and markers automatically update to display the new value.

Dedicated Direct Keypad Data Entry of Major Measurement Parameters

Enables fast, accurate instrument set-up—user is prompted by screen messages for proper keypad inputs—all "valid" keys to push are illuminated to steer users to proper selections. Unique marker keypad allows for Peak Find, Right and Left Next, Next Higher and Lower, Left and Right ×dB, and Peak Find and Center to be executed direct from the front panel. This makes signal searches much easier.

Meet Your System Needs
Fully Automated Spectrum Analysis

The 2756P is a fully GPIB-programmable laboratory spectrum analyzer. It simplifies programming and ensures measurement repeatability. You can operate the 2756P under program control, change front-panel settings, read data from the CRT display, and send waveforms from internal memory to other GPIB devices. Tek's Standard Codes and Formats keep commands clear, consistent, and universally understood.

Millimeter Wave Capability

Using Tek's high performance waveguide mixers, you get calibrated amplitude and frequency coverage from 18 to 325 GHz. Real signals are determined in two sweeps with Tek's accurate millimeter wave identification mode. No costly L.O. amp is needed—just some simple connections and you're ready to measure.

Tektronix Automated Spectrum Analyzer Packages

Convenient to order, these packages are configured around Compaq's PC, Tek's laboratory quality programmable 2750P Series spectrum analyzers. Coupling the PC to the analyzer via the IEEE-488 bus enables the user to take advantage of the

PC's capability, as well as the power and versatility of Tek's spectrum analyzers. A highly versatile General RF Applications Software Package (GRASP) offers many different applications and utility routines which are selected through easy, menu-driven operation. Also EMI software is available for FCC, VDE, CISPR, and MIL Standard testing.

Perfect Fit for Rackmount Needs

The 2756P is desinged to easily rackmounted in a standard 19″ rack. With Options 30 or 31 the 2756P becomes a 7″-high rackmounted spectrum analyzer. Option 30 provides for rackmount with inputs on the front of the instrument and Option 31 provides for inputs at the rear of the instrument.

There are many other time-saving and accuracy-enhancing capabilities too numerous to discuss here. See the summary of signal processing and marker functions on page 167 for a more complete idea of the 2756P measurement benefits. Talk to your Tektronix Spectrum Analyzer Sales Engineer for complete details.

CHARACTERISTICS

The following characteristics apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range—10 kHz to 21 GHz in coax, 18 to 325 GHz in external waveguide mixers.

Center and Marker Frequency Accuracy—± [20%D + (F × REF) + (2N + 25) Hz] with Span/Div ≤200 kHz for Bands 1 & 5-12 or Span/Div ≤100 kHz for Bands 2-4 (phase locked); Otherwise (unlocked) ± [20%D + (F×REF + (15N) kHz].

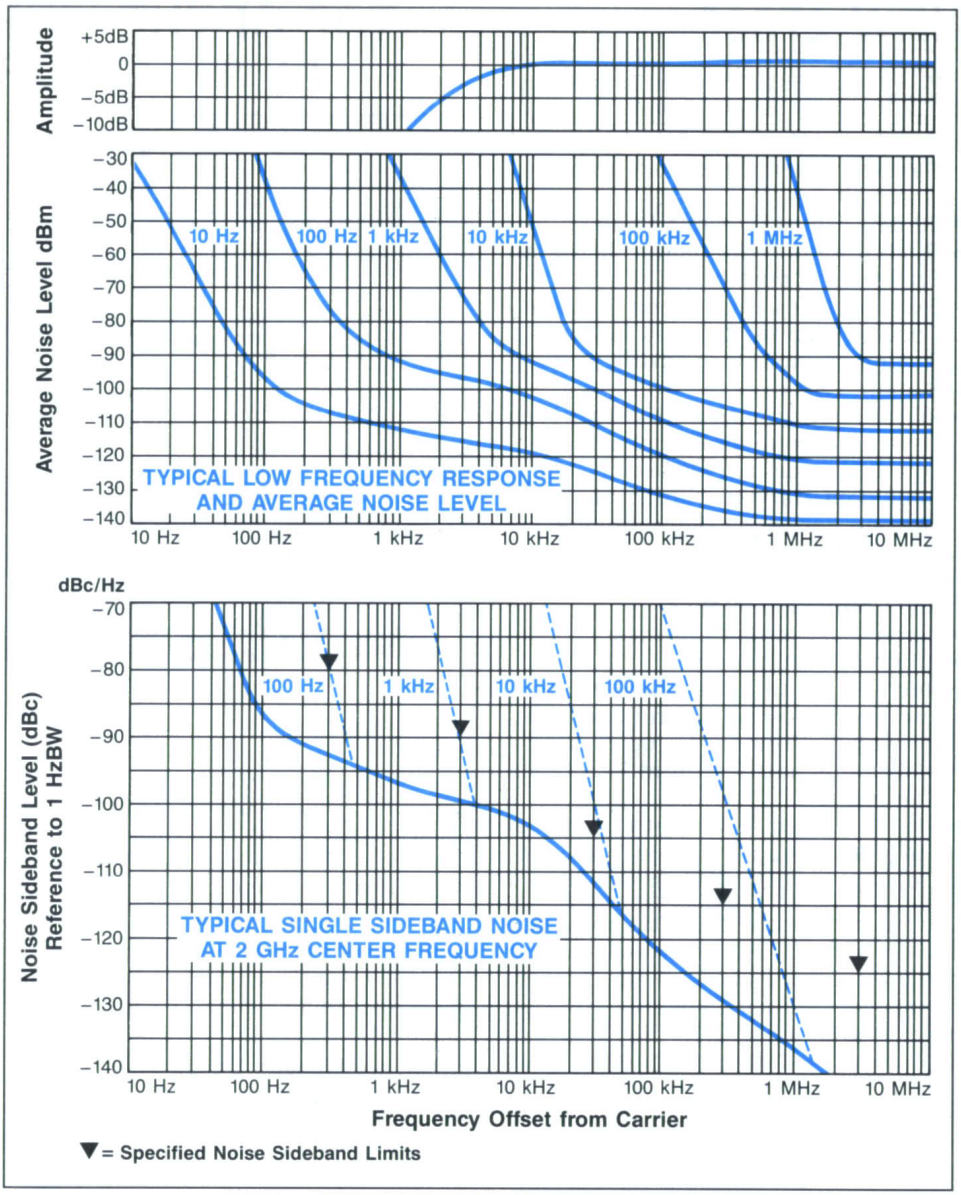
Where: D = Span/Div or Resolution BW, whichever is greater.
F = Center or Marker Frequency.
N = Harmonic Mixing Number.
REF = Reference Frequency Error.

Delta Marker Frequency Accuracy—±1% of Total Span.

Frequency Drift (After 1-hour warm-up)—Span/Div ≤200 kHz for Bands 1 & 5-12 or Span/Div ≤100 kHz for Bands 2-4 (phase locked): Drift rate ≤50 Hz/min. Correction will occur at the end of sweep for sweep times ≥5 s/Div. (Drift rate is typically <20 Hz/min after 1-hour warm-up from 25°C storage.) Span/Div >200 kHz for Bands 1 & 5-12 or Span/Div >100 kHz for Band 2-4 (unlocked): Drift rate <(5 kHz)N/min (typically <(25 kHz)N/min after 30-minute warm-up).

Residual FM—≤(5 + N) Hz peak-to-peak in 20 msec, Span/Div ≤200 kHz for bands 1 & 5-12 or Span/Div ≤100 kHz for Bands 2-4 (phase locked); Otherwise (unlocked) ≤(7 kHz)N peak-to-peak in 20 msec.

Frequency Readout Resolution—≤10% of Span/Div to 1 Hz minimum.



SENSITIVITY AND FREQUENCY RESPONSE

Band and Frequency Range	Harmonic Number	Sensitivity (dBm) at Minimum Resolution	Frequency Response (dB)*1
1 (10 kHz-1.8 GHz)	1	−134	±1.5
2 (1.7-5.5 GHz)	1	−125	±2.5
3 (3.0-7.1 GHz)	1	−125	±2.5
4 (5.4-12 GHz) 12.0-18.0 GHz)	3	−111 −107	±3.5
5 (15.0-21.0 GHz)	3	−106	±5.0
6 (18-27 GHz)	6	−116	±2.0
7 (26-40 GHz)	10	−111	±2.0
8 (33-50 GHz) 40-60 GHz	10	−111	±2.0 ±2.5
9 (50-90 GHz	15	−105 at 50 GHz; −95 at 90 GHz	±3.0
10 (75-140 GHz)*2	23	−100 at 75 GHz; −85 at 140 GHz	±3.0
11 (110-220 GHz)*2	37	−90 at 100 GHz; −75 at 220 GHz	±3.0
12 (170-325 GHz)*2	56	−70 at 170 GHz; −55 at 325 GHz	±3.0

*1 *Measured with 10 dB RF Attenuation and peaking optimized. Frequency response is with ±4.5 dB from 10 kHz to 18 GHz.*

*2 *Frequency response for any 5-GHz band. Response is within ±6 dB referenced to 100 MHz.*

Reference Frequency Error (Internal)—$\leq 1 \times 10^{-9}$ per day; $\leq 1 \times 10^{-7}$ in the first six months, $\leq 1 \times 10^{-7}$ per year thereafter; Accuracy 30 minutes after power on within 5×10^{-8} of the frequency after 24 hours; Within 2×10^{-8} over the temperature range of −15 to +55 °C.
Signal Counter Accuracy—± [(F × REF) + (5 + N) Hz + 1 LSD].
Delta Counter Accuracy—± [(Delta F × REF) + (10 + 2N) Hz + 1 LSD]
Where: F = Center or Marker Frequency.
REF = Reference Frequency Error.
N = Harmonic Mixing Number.
LSD = Least Significant Digit.
Counter Sensitivity—Signal level must be ≥20 dB above the average noise level and within 60 dB of the reference level.
Counter Readout Resolution—Selectable from 1 Hz to 1 GHz in decade steps.
Resolution Filters—10 Hz to 3 MHz; 10 Hz to 1 MHz in decade steps; 6 dB bandwidth ±20%; Shape factor ≤7.5:1 except 10 Hz where 60 dB BW ≤150 Hz.
Frequency Span/Division—0 Hz (ZERO SPAN pushbutton, knob or kepad data entry); 10 Hz to 10 GHz (in a 1-2-5 sequence) via Span/Div knob; 10 Hz to 15 GHz (to two significant digits) via FREQUENCY or MARKER.
START/STOP or keypad data entry; 180 MHz via power-up or RESET: Full band via knob or MAX SPAN pushbutton; Multiband spans in Bands 2-5 (1.7 to 21 GHz) via START/STOP FREQUENCY mode; accuracy ±5% for Span/Div ≥50 Hz, ±10% for Span/Div <50 Hz.
Frequency Response Sensitivity—See chart on page 172.

AMPLITUDE RELATED

Display Dynamic Range—90 dB Log mode; eight divisions Linear mode.
Reference Level Range—
Log Mode: −117 to +50 dBm (+30 dBm maximum); −130 to +37 dBV (+17 dBV maximum); −70 to +97 dBmV (+77 dBmV maximum); −10 to +157 dBμV (+137 dBμV maximum).
Linear Mode: 39.6 nV/Div to 2.8 V/Div (1 watt or 10 V_{peak} maximum).

Noise Sidebands

dBc/Hz	Offset from Carrier
− 80	300 Hz
− 90	3 kHz
− 105	30 kHz
− 115	300 kHz
− 125	3 MHz

Power Line Related Sidebands—≤ −55 dBc for line frequencies from 47 to 440 Hz.

TIME RELATED

Sweep Time—20 μs to 5 s/div (10 s/div in Auto) in a 1-2-5 sequence; accuracy ±5%.
Marker Time Accuracy—±10% (indicates time from start of sweep).
ΔMarker Time Accuracy—±5% (indicates time between two markers).

INPUT

RF Input—Type "N" female, 50 Ω nominal impedance.

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
10 kHz to 2.5 GHz	1.3:1 Max 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max 2.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max 2.7:1 Typical	3.0:1

Maximum Safe Input (0 dB RF Attenuation—+30 dBm (1 W) continuous, 75 W peak, 1 μsec pulsewidth, 0.001 duty; 0 V dc.
1 dB Gain Compression—−10 dBm with 0 dB RF attenuation in MIN NOISE. −20 dBm with 0 dB RF attenuation in MIN DISTORTION.
External Mixer Input—Front-panel TNC female connector for IF frequency inputs from external mixers covering 18 to 325 GHz.
External Reference Input—
Frequency: 1, 2, 5, or 10 MHz with ≤5 ppm stability.
Power Range: −15 to +15 dBm.
Waveshape: Sine wave, ECL, TTL (Allowable Duty cycle symmetry is 40 to 60%).
Input Impedance: 50 Ω ac, 500 Ω dc; rear-panel BNC input.

CHARACTERISTICS

50/75 Ω OPTION 07
75 Ω INPUT RELATED

Provides 75 Ω input and dBmV calibration in addition to the normal 50 Ω input and dBm calibration. The 100 kHz resolution filter is replaced by 300 kHz to optimize the instrument for broadcast and CATV uses.
Center Frequency Range—1 to 1000 MHz.
Frequency Response—±2.0 dB from 5 to 1000 MHz; typical response for the 1 to 5 MHz frequency range is <3 dB down from the 5 MHz response.
Reference Level Range—−68 to +79 dBmV (+89 dBmV is achievable in MIN NOISE mode) and +99 dBmV in Reduced Gain mode.

Sensitivity (Equivalent Input Noise): 5 to 1000 MHz—75 Ω Input

Sensitivity dBmV	Resolution Bandwidth
−81	30 Hz
−76	100 Hz
−66	1 kHz
−56	10 kHz
−41	300 kHz
−36	1 MHz
50 Ω RF Input	
−90 (dBm)	300 kHz

Input Impedance—75 Ω; VSWR 1.35:1 (17 dB RL) maximum, 5 to 800 MHz; VSWR 1.6:1 (13 dB RL) maximum, 800 to 1000 MHz; BNC female.
Maximum Input Level—With 0 dB attenuation: +78 dBmV. With attenuation >20 dB: +78 dBmV, 100 V maximum (dc + ac peak).
Calibrator (Cal Out)—+20 dBmV ±0.5 dB; 75 Ω impedance nominal.

ORDERING INFORMATION

2756P Programmable Spectrum Analyzer. **$47,995**
Includes: Same as 2753P except operator's manual (070-6317-00); programmer's manual (070-6320-00).

OPTIONS

Option 07—75 Ω input. **+$750**
Includes: BNC male to female adaptor connector (013-0126-00); 42-in. BNC to BNC connector 75 Ω coax cable (012-0074-00).
Option 21—18 to 40 GHz High Performance Waveguide Mixer Set. **+2,650**
Includes: Diplexer assembly (015-0385-00); BNC-to-SMA adaptor (015-0388-00); power cord clamp (343-0170-00); SMA-to-SMA cable (012-0649-00).
Option 22—18 to 60 GHz High Performance Waveguide Mixer Set. **+$4,460**
Includes: Same as Option 21.
Options 23, 24, 25, 26, 28, 29—Bundled software and computer packages available in U.S. only. Contact your local sales representative.
Option 30—Rackmount. **+$250**
Option 31—Rackmount with rear-panel input/output connectors. **+$450**
Option 39—Replaces Lithium with Silver batteries for instrument memory. **+$50**
Option 41—Digital Radio Enhancement. **+$450**
Option 42—110 MHz, >5 MHz bandwidth, IF Output suitable for broadband receiver measurements. **+$1,500**
Option 43—Alternate CRT. **+$250**
Option 45—MATE/CIIL language interface. **+$4,975**
Option 52*[1]—North American 220 V configuration with standard power cord.
Option B1—Service manuals **+$50**
(Vol. 1) 070-6306-00.
(Vol. 2) 070-6307-00.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Service section.
Option M1—2 Calibrations. **+$2,120**
Option M2—2 Years Service. **+$3,770**
Option M3—2 Years Service and 4 Calibrations. **+$4,240**

OPTIONAL ACCESSORIES

See page 170 for 2756P optional accessory information.

*[1] *To order, contact your local Tektronix Sales Office.*

2755/2755P

GPIB IEEE-488 The 2755 and 2755P comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Lab Performance Packaged for Engineering and Manufacturing Productivity**
- **50 kHz to 21 GHz Coverage in Coax and to 325 GHz Using Tek Waveguide Mixers**
- **Marker and Center Frequency Accuracy of One Part in 10^5**
- **Built-in Marker Intelligence**
  - **—Exclusive Occupied Bandwidth Mode**
  - **—Menu-Selectable Signal Processing**
  - **—Signal Search Functions**
  - **—Noise Normalization to 1 Hz**
  - **—Alternate Reference Units**
- **Large, Easy-to-Use Controls**
- **Nonvolatile Memory for Up to Nine Waveforms and Nine Front-Panel Displays**
- **Direct Keypad Entry of Control Parameters**
- **Direct Plot Capability (All Versions)**
- **GPIB/Fully Programmable (2755P)**
- **Optional Preselector**

Now There is a Tek Spectrum Analyzer Especially for the Laboratory

The Tektronix 2755 is a benchtop instrument that combines cost-effective lab performance and ease of use with a new dimension in spectrum analyzer processing intelligence. Packaged for enhanced engineering productivity, it reduces operator interface requirements and risk of human error. You'll make measurements faster and more accurately than ever before, all with the high standard of Tektronix quality and reliability.

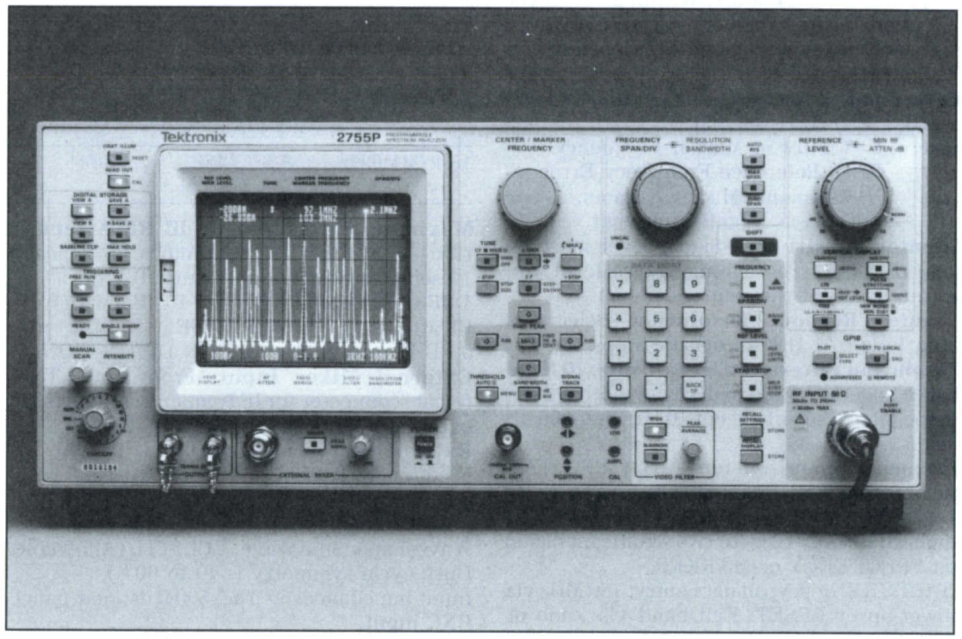
Decision-Making Power at the Touch of a Button

Tek exclusives include signal processing intelligence that can discriminate and sort among continuous wave (CW), pulse and spurious signals. Hands-off convenience for measuring the bandwidth of filters, amplifiers, and channelized spectrum occupancy is provided by Tek's new BANDWIDTH mode. For a summary of signal processing functions, see page 167.

Tedious, time-consuming calculations are eliminated with automatic noise normalization to 1 Hz and alternate reference units such as dBm, dBmV, dBμV, and dBV.

Feature for feature, the 2755 is optimized for straightforward operation and outstanding ease of use—from the ergonomically designed front panel and larger controls to direct keypad entry of important control factors.

EASY TO USE... LAB PERFORMANCE PACKAGES



Millimeter Wave Capability

Using Tek's high performance waveguide mixers, you get calibrated amplitude and frequency coverage from 18 to 325 GHz. Real signals are determined in two sweeps with Tek's accurate millimeter wave identification mode. No costly L.O. amp is needed—just some simple connections and you're ready to measure.

Use as a Systems Component

The 2755P is the GPIB-programmable version of the 2755. Featuring Tek *Codes and Formats*, programming is easy to implement with English-like commands. With TekSPANS® software you can use the 2755P with popular controllers including the Compaq PC and PC-compatibles.

As an option, you can also rackmount the 2755 for use in the manufacturing or test environment not requiring instrument mobility.

CHARACTERISTICS

FREQUENCY RELATED

Frequency Range—50 kHz to 21 GHz coaxial input; 50 kHz to 325 GHz external mixer input (amplitude specified from 18 to 325 GHz with Tektronix WM 490 Series Waveguide Mixers).

Center and Marker Frequency Accuracy*1—Phase Locked: $\pm[20\%D + (F\times10^{-5})]$ Hz, Bands 1 and 5-12 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz. Unlocked: $\pm[20\%D + (F\times10^{-5}) + 15\ NkHz]$.

Where: D=Span/div or Res BW, whichever is greater.
F=Center or Marker Frequency
N=Harmonic Mixing Number

*1 *Over the operating temperature extremes of 0 to +50°C, 1.5×10^{-5}.*

Delta Marker Frequency Accuracy—1% of total span.

Center Frequency Drift (After 1-Hour Warm-Up)—Phase Locked: ≤50 Hz per minute of sweep time corrected at least every 30 seconds. Bands 1 and 5-12 with span/div ≤200 kHz, and bands 2-4 with span/div ≤100 kHz. Unlocked: ≤(5 kHz) N per minute of sweep time.

Frequency Readout Resolution—≤10% span/div to 1 kHz minimum. (100 Hz in Delta Marker Mode.)

Residual FM—Phase Locked: ≤(10 + 2N) Hz p-p in 20 ms, Bands 1 and 5-12 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz. Unlocked: ≤(7 kHz) N p-p in 20 ms.

Noise Sidebands

dBc/Hz	Offset from Center
≤ −95	3 kHz
≤ −105	30 kHz
≤ −115	300 kHz

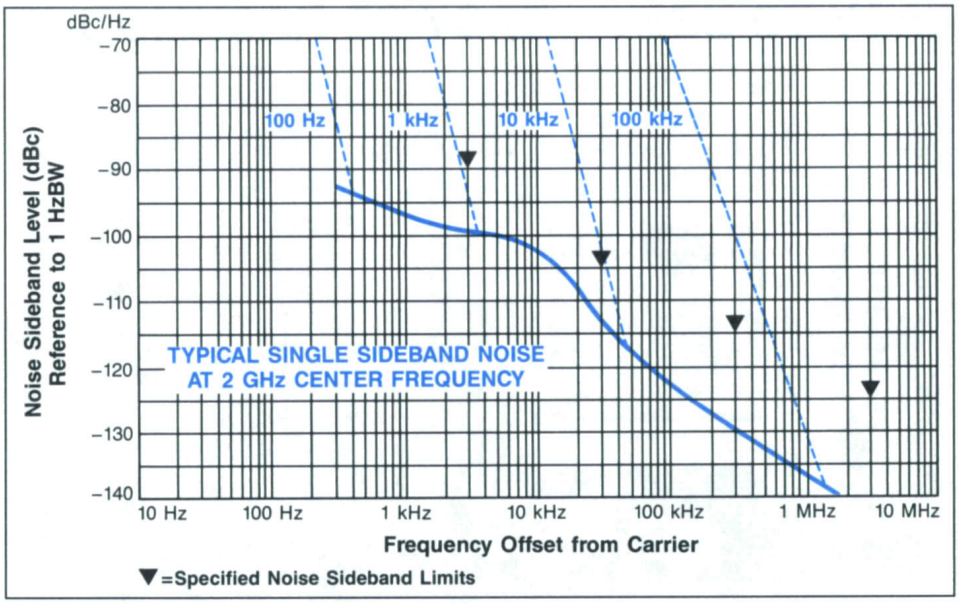
Resolution Filters—100 Hz to 1 MHz (6 dB bandwidth ±20%) in decade steps. Shape factor ≤7.5: 1 (60 dB/6 dB).

Frequency Span/Division—0 Hz (zero span pushbutton or data entry keypad); 200 Hz to 10 GHz (in a 1-2-5 sequence) via span/div knob; 200 Hz to 15 GHz (to two significant digits) via keypad or start/stop data entry, or marker start/stop; full band via MAX SPAN pushbutton (12 bands). Accuracy ±5% of selected span/div.

AMPLITUDE RELATED

Display Dynamic Range—80 dB log mode; eight divisions linear.

Frequency Response and Sensitivity—Refer to chart on page 175.



SENSITIVITY AND FREQUENCY RESPONSE*4

Band and Frequency Range	Harmonic Number	Sensitivity (dBm) at Minimum Resolution	Frequency Response (dB)*1
1 (50 kHz-4.2 GHz)*2	1	−125	±1.5
2 (1.7-5.5 GHz)*2	1	−125	±1.5
3 (3.0-7.1 GHz)*2	1	−125	±1.5
4 (5.4-18 GHz)*2	3	−110	±2.5
5 (15-21 GHz)	3	−106	±3.5
6 (18-27 GHz)	6	−108	±2.0
7 (26-40 GHz)	10	−103	±2.0
8 (33-60 GHz)	10	−103	±2.2 33 to 50 GHz ±2.5 40 to 60 GHz
9 (50-90 GHz)*3	15	−105 at 50 GHz; −95 at 90 GHz	±3.0
10 (75-140 GHz)*3	23	−100 at 75 GHz; −85 at 140 GHz	±3.0
11 (110-220 GHz)*3	37	−90 at 110 GHz; −75 at 220 GHz	±3.0
12 (170-325 GHz)*3	56	−70 at 170 GHz; −55 at 325 GHz	±3.0

*1 *Measured with 10 dB RF Attenuation and peaking optimized (when applicable). Frequency response within ±3.5 dB from 50 kHz to 18 GHz referenced to 100 MHz (±4.5 dB for Option 01).*
*2 *Band 1 is limited to 50 kHz to 1.8 GHz for preselected (Option 01) units. The preselector degrades minimum sensitivity by 5 dB (6 dB in BAND 3) and degrades frequency response by ±1.0 dB to 18 GHz; ±1.5 dB to 21 GHz.*
*3 *Frequency response for any 5 GHz band. Response is within ±6 dB referenced to 100 MHz.*
*4 *Refer to page 177 for 2755/2755P typical low frequency response graph.*

Harmonic Distortion—≤ −60 dBc for a −40 dBm input 50 kHz to 21 GHz in MIN Distortion mode. Not discernible above the noise (typically −100 dBc) for preselected bands (Option 01 only).

INPUT SIGNAL

RF Input Type—"N" female 50 Ω nominal impedance. Refer to Option 07 characteristics.
Maximum Safe Input—+30 dBm CW with ≥20 dB attenuation; +13 dBm CW with 0 dB attenuation; 0 V dc. Option 01: +30 dBm (1 W) CW; 75 W peak, 1 μs Pulse width, 0.001 duty; 0 dB attenuation. Do not apply dc.
1 dB Gain Compression—≥ −18 dBm in MIN Distortion Mode.

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
50 kHz to 2.5 GHz	1.3:1 Max; 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max; 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max; 1.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max; 2.7:1 Typical	3.0:1

Measured at ±3 MHz of preselector peak for Option 01.

Option 07—See page 177 for information.

ORDERING INFORMATION

2755 Spectrum Analyzer **$28,500**
Includes: 50 Ω coax cable, N to N connector, 6 ft (012-0114-00); 50 Ω coax cable, BNC to BNC connector, 18 in. (012-0076-00); service manual Vol. 1 (070-6032-00); service manual Vol. 2 (070-6033-00); operator's manual (070-6031-00); N male to BNC female adaptor; 2 Fast-Blo, 4A fuses; power cord (161-0104-00); power cord clamp (343-0170-00); CRT amber light filter (378-0115-01); gray CRT light filter (378-0115-02); CRT mesh filter (378-0887-00).
2755P Programmable Spectrum Analyzer **$30,000**
Includes: Same as 2755 plus programmer's manual (070-6034-00).

OPTIONS

Option 01—Adds preselection **+$3,995**
Option 07—75 Ω input. **+$750**
Includes: BNC male to female adaptor connector (013-0126-00); 42-in. BNC to BNC connector 75-Ω coax cable (012-0074-00).
Option 08—Deletes external mixer. **−$1,750**
Option 21—18 to 40 GHz High Performance Waveguide Mixer Set. **+$2,650**
Includes: Diplexer assembly (015-0385-00); BNC-to-SMA adaptor (015-0388-00); power cord clamp (343-0170-00); SMA-to-SMA cable (012-0649-00).
Option 22—18 to 60 GHz High Performance Waveguide Mixer Set. **+$4,460**
Includes: Same as Option 21.
Options 23, 24, 25, 26, 27, 28, 29—Bundled software and computer packages available in U.S. only. Contact your local sales representative.
Option 30—Rackmount. **+$250**
Option 31—Rackmount with rear-panel input/output connectors. **+$450**
Option 39—Replaces Lithium with Silver batteries for instrument memory. **+$50**
Option 41—Digital Radio Enhancement. **+$450**
Option 42—110 MHz, >5 MHz bandwidth, IF Output suitable for broadband receiver measurements. **+$750**
Option 43—Alternate CRT*1.
Option 45—MATE/CIIL language interface. **+$4,975**
Option 52*1—North American 220 V configuration with standard power cord.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Service section.
Option M1—2 Calibrations.
(2755) **+$1,995**
(2755P) **+$2,025**
Option M2—2 Years Service.
(2755) **+$3,380**
(2755P) **+$3,510**
Option M3—2 Years Service and 4 Calibrations.
(2755) **+$3,995**
(2755P) **+$4,045**

OPTIONAL ACCESSORIES

External Waveguide Mixers—
(18 to 26.5 GHz) Order WM 490K. **$1,310**
(26.5 to 40 GHz) Order WM 490A. **$1,310**
(33 to 50 GHz) Order WM 490Q. **$1,520**
(40 to 60 GHz) Order WM 490U. **$1,805**
(50 to 75 GHz) Order WM 490V. **$2,045**
(60 to 90 GHz) Order WM 490E. **$2,225**
(75 to 110 GHz) Order WM 490W. **$2,280**
(90 to 140 GHz) Order WM 490F. **$2,445**
(110 to 170 GHz) Order WM 490D. **$3,410**
(140 to 220 GHz) Order WM 490G. **$3,490**
Tapered Transition—Used with WM 490G, 220 to 325 GHz. Order 119-1728-00 **$1,200**
Microwave Comb Generator— TM 500-Series compatible. Order 067-0885-00 **$1,815**
1405 TV Sideband Analyzer Adaptor—525/60 markers (Opt 02 required for 275X & 49X). **$5,780**
TR 503 Tracking Generator— 100 kHz to 1.8 GHz. **$7,080**

*1 *To order, contact your local Tektronix Sales Office.*

2754/2754P

GPIB IEEE-488 — The 2754 and 2754P comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Rackmountable for Engineering and Manufacturing System Productivity (2754)**
- **Marker and Center Frequency Accuracy of One Part in 10^5**
- **Built-In Signal Processing Intelligence**
  - **—Search, Sort and Mark CW, Pulse or Spurious Signals**
  - **—Exclusive Occupied Bandwidth Mode**
  - **—Signal Tracking**
  - **—Noise Normalization to 1 Hz**
- **Nonvolatile Memory for Storage of Up to Nine Waveforms and Nine Front-Panel Displays**
- **Direct Keypad Entry of Control Parameters**
- **Large, Easy-to-Use Controls**
- **Direct Plot Capability (All Versions)**
- **1-kHz Resolution Bandwidth**
- **Preselector (Optional)**

Now There is a Tek Spectrum Analyzer Especially for the Engineering Labs and Manufacturing Systems

The Tektronix 2754 Spectrum Analyzer combines cost-effective lab performance and ease of use with a new dimension in Spectrum Analyzer signal processing intelligence. Packaged for enhanced productivity, it reduces operator interface requirements and risk of human error. You'll make measurements faster and more accurately than ever before. All with the high standard of Tektronix quality and reliability.

Decision-Making Power at the Touch of a Button

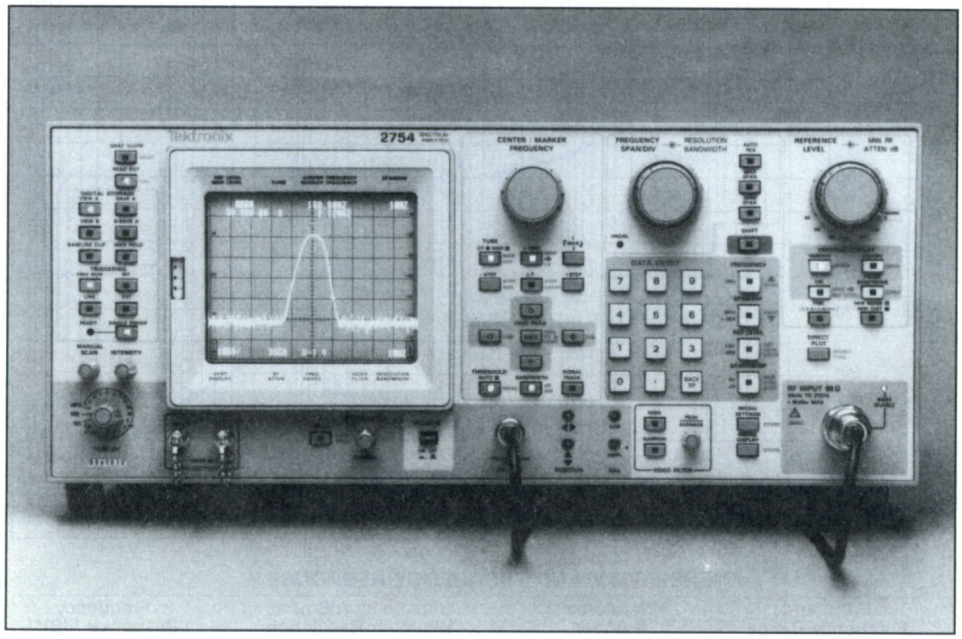
Tek exclusives include marker signal processing intelligence that can discriminate and sort among continuous wave (CW), pulse, and spurious signals. Hands-off convenience for measuring the bandwidth of filters, amplifiers, and channelized spectrum occupancy is provided by Tek's new BANDWIDTH mode. For a summary of signal processing functions, see page 167.

Tedious, time-consuming calculations are eliminated with automatic noise normalization to 1 Hz and alternate reference units such as dBm, dBmV, dBμV, and dBV.

Value Packed

Feature for feature, the 2754 is optimized for straightforward operation and outstanding ease of use from the ergonomically designed front panel and larger controls to direct keypad entry of important control factors.

EASY TO USE. . . EASY TO RACKMOUNT



Use as a Systems Component

The 2754P is the GPIB-programmable version of the 2754 and features Tek *Standard Codes and Formats*, making programming easy to implement with English-like commands. With Tek-SPANS® software you can use the 2754P with popular controllers including the Compaq PC and PC-compatibles.

As an option, you can quickly and easily rackmount the 2754 for use in the manufacturing or test environment not requiring instrument mobility.

CHARACTERISTICS

The following characteristics apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range—50 kHz to 21 GHz coaxial input.

Center and Marker Frequency Accuracy*1—Phase Locked: $\pm[20\%D + (F\times10^{-5})]$ Hz; Bands 1 and 5 with span/div; ≤200 kHz, and Bands 24 with span/div ≤100 kHz. Unlocked: $\pm[20\%D + (F\times10^{-5} + 15\ \text{NkHz}]$.

Where: D = Span/div or Res BW, whichever is greater.
F = Center or Marker Frequency
N = Harmonic Mixing Number

Delta Marker Frequency Accuracy—1% of total span.

Center Frequency Drift (After 1 Hour Warm-Up)—≤50 Hz per minute of sweep time corrected at least every 30 seconds. Phase Locked: Bands 1 and 5 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz. Unlocked: ≤(5 kHz) N per minute of sweep time.

*1 *Over the operating temperature extremes of 0 to +50°C, 1.5×10^{-5}.*

Frequency Readout Resolution—≤10% span/div to 1 kHz minimum. (100 Hz in Delta Marker Mode).

Residual FM—Phase Locked: ≤(10 +2N) Hz peak-to-peak in 20 ms, Bands 1 and 5 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz. Unlocked: ≤(7 kHz) N peak-to-peak in 20 ms.

Resolution Filters—1 kHz to 1 MHz (6 dB bandwidth ±20%) indecade steps. Shape factor ≤7.5:1 (60 dB/6 dB).

Video Filter Range—3Hz to 30 kHz (coupled to resolution filter by front-panel pushbuttons).

Frequency Span/Division—0 Hz (zero span pushbutton or data entry keypad); 200 Hz to 1 GHz (in a 1-2-5 sequence) via span/div knob; 200 Hz to 1.2 GHz (to two significant digits) via keypad or start/stop data entry, or marker start/stop; full band via MAX SPAN pushbutton (5 bands). Accuracy ±5% of selected span/div.

AMPLITUDE RELATED

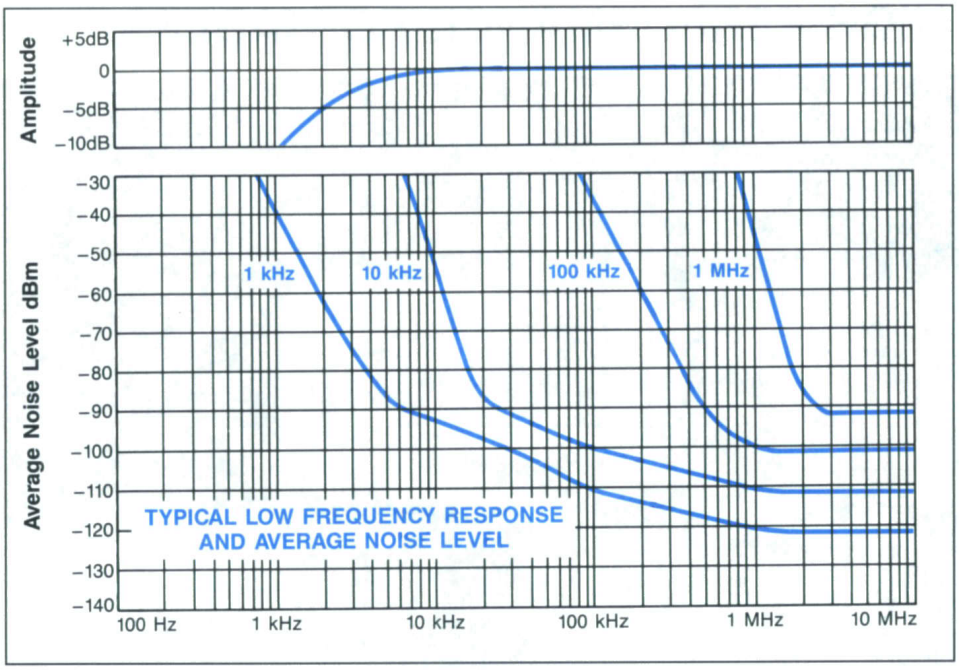
Display Dynamic Range—80 dB log mode; eight divisions linear.

Reference Level Range—Log Mode: −117 to +40 dBm, +30 dBm maximum input level; −130 to +27 dBV, +17 dBV maximum input level; −70 to +87 dBmV, +77 dBmV maximum input level; −10 to +147 dBμV, +137 dBμV maximum input level level. Linear Mode: 39.6 nV/div to 2.8 V/div, 1 W maximum input level.

Harmonic Distortion—(Option 01 only) ≤−60 dBc for a −40 dBm input 50 kHz to 21 GHz in MIN Distortion mode. Not discernible above the noise (typically −100 dBc) for preselected bands.

Noise Sidebands

dBc/Hz	Offset From Carrier
≤−105	30 kHz
≤−115	300 kHz



1. Delete 100 Hz curve for 2754/2754P.
2. Refer to page 175 2755/2755P Typical Single Sideband Noise graph and delete 100 Hz curve for the 2754/2754P.

SENSITIVITY AND FREQUENCY RESPONSE

Band and Frequency Range	Harmonic Number	Sensitivity (dBm) at Minimum Resolution	Frequency Response (dB)*2
1 (50 kHz-4.2 GHz)*1	1	−115	±1.5
2 (1.7-5.5 GHz)*1	1	−115	±1.5
3 (3.0-7.1 GHz)*1	1	−115	±1.5
4 (5.4-18 GHz)*1	3	−100	±2.5
(12-18 GHz)	3	−95	±2.5
5 (15-21 GHz)*1	3	−95	±3.5

*1 *Band 1 is limited to 50 kHz to 1.8 GHz for preselected (Option 01) units. The preselector degrades minimum sensitivy by 5 dB (6 dB in BAND 3) and degrades frequency response by ±1.0 dB to 18 GHz; ±1.5 dB to 21 GHz.*
*2 *Measured with 10 dB RF Attenuation and peaking optimized (when applicable). Frequency response within ±3.5 dB from 50 kHz to 18 GHz referenced to 100 MHz (±4.5 dB for Option 01).*

INPUT SIGNAL

RF Input—Type "N" female 50 Ω nominal impedance.
Maximum Safe Input—+30 dBm CW with ≥20 dB attenuation; +13 dBm CW with 0 dB attenuation; 0 V dc.
Option 01: +30 dBm (1 W) CW; 75 W peak, 1μs pulse width, 0.001 duty; 0 dB attenuation. Do not apply dc.
1 dB Gain Compression—−10 dBm with 0 dB RF Attenuation in MIN NOISE; −20 dBm with 0 dB RF Attenuation in MIN DISTORTION (No gain compression can be observed on screen).

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
50 kHz to 2.5 GHz	1.3:1 Max; 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max; 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max; 1.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max; 2.7:1 Typical	3.0:1

Measured at ±3 MHz of preselector peak for Option 01.

CHARACTERISTICS

50 Ω/75 Ω OPTION 07
75 Ω INPUT RELATED

See page 189 for information.

ORDERING INFORMATION

2754 Spectrum Analyzer **$22,995**
Includes: 50-Ω coax cable, N to N connector, 6 ft; (012-0114-00); 50-Ω coax cable, BNC to BNC connector, 18 in. (012-0076-00); service manual Vol. 1 (070-6097-00); service manual Vol. 2 (070-6098-00); operator's manual (070-6096-00); N male to BNC female adaptor; 2 Fast-Blo, 4A fuses; power cord (161-0104-00); power cord clamp (343-0170-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); CRT mesh filter (378-0887-00).
2754P Programmable Spectrum Analyzer **$23,995**
Includes: Same as 2754 plus programmer's manual (070-6099-00).

OPTIONS

Option 01—(2755/2755P/2754/ 2754P) Adds preselection **+$3,995**
Option 07—75 Ω input. **+$750**
Includes: BNC male to female adaptor connector (013-0126-00); 42-in. BNC to BNC connector 75-Ω coax cable (012-0074-00).
Option 30—Rackmount. **$250**
Option 31—Rackmount with rear-panel input/output connectors. **$450**
Option 52*1—North American 220 V configuration with standard power cord.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

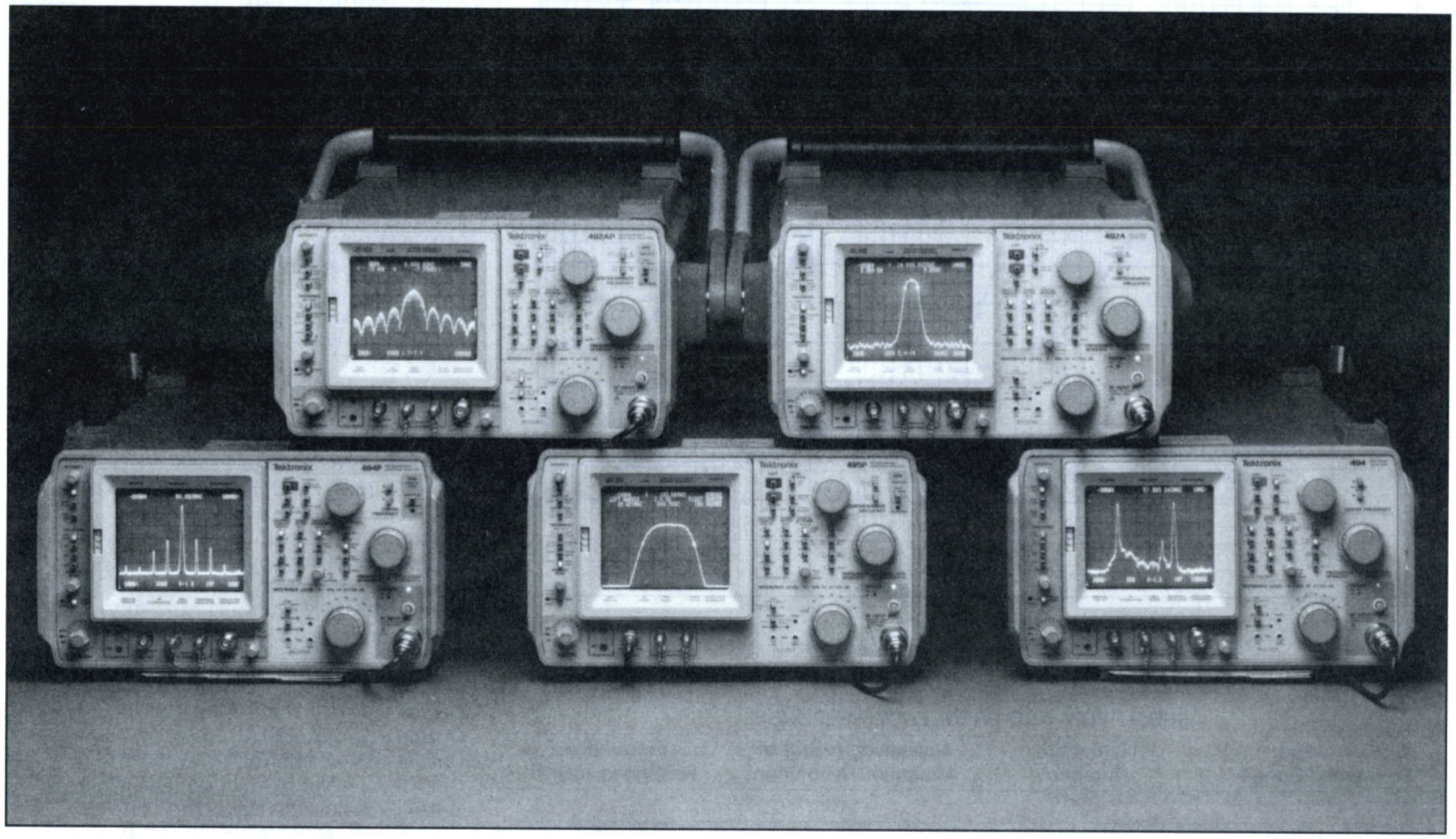
See Service section.
Option M1—2 Calibrations.
(2754) **+$1,995**
(2754P) **+$2,025**
Option M2—2 Years Service.
(2754) **+$3,380**
(2754P) **+$3,510**
Option M3—2 Years Service and 4 Calibrations.
(2754) **+$3,995**
(2754P) **+$4,045**

OPTIONAL ACCESSORIES

Microwave Comb Generator—TM 500-Series compatible.
Order 067-0885-00 **$1,815**
1405 TV Sideband Analyzer adaptor—525/60 markers (Opt 02 required for 275X & 49X). **$5,780**
TR 503 Tracking Generator—100 kHz to 1.8 GHz. **$7,080**

*1 *To order, contact your local Tektronix Sales Office.*

PACE-SETTING HIGH PERFORMANCE PORTABLES



- **Frequency Coverage from 100 Hz to 325 GHz**
- **Ruggedized for Harsh Field Environments**
- **HELP Mode—Operator's Manual in ROM**
- **Many Application-Specific Performance Enhancement Options**

ANCILLARY PRODUCTS

Product	Description/Feature	Page
TekSPANS	Software	195
WM490 Series	Waveguide Mixers 18 to 325 GHz	191
1405	TV Sideband adaptor	201
TR503	Tracking Generator	201

490 SERIES PORTABLE SPECTRUM ANALYZERS SUMMARY

Model	Frequency Range	Resolution Range	Average Noise Level (Minimum BW)	Amplitude Measurement Range	GPIB Capability	Display Dynamic Range	Frequency Accuracy	Page	Prices Begin At
492A	50 kHz to 325 GHz	1 MHz to 100 Hz	−125 dBm	+30 to −125 dBm		80 dB	±[(20% Span/Div or Res BW) +(Center or Marker Freq) × 10^{-5}] Hz	187	$29,040
492AP	50 kHz to 325 GHz	1 MHz to 100 Hz	−125 dBm	+30 to −125 dBm	Full	80 dB		187	$30,500
NEW 494A	10 kHz to 325 GHz	3 MHZ to 10 Hz	−134 dBm	+30 to −134 dBm	Direct Plot	90 dB	±[(2% Span or Res BW) +(Center or Marker Freq) ×10^{-9}) +(2N + 25 Hz)]	180	$43,700
NEW 494AP	10 kHz to 325 GHz	3 MHZ to 10 Hz	−134 dBm	+30 to −134 dBm	Full	90 dB		180	47,995
494P	10 kHz to 325 GHz	1 MHz to 30 Hz	−121 dBm	+30 to −121 dBm	Full	80 dB	±[(2% Span or Res BW) +(CF × Ref Error) +(2N + 25 Hz)]	190	$52,000
495	100 Hz to 1.8 GHz	3 MHz to 10 Hz	−130 dBm	+30 to −130 dBm	Direct Plot	90 dB	±[(2% Span or Res BW) +(F × Ref Error) + 15 Hz Where: F=Center or Marker Freq Ref Error=10^{-5} Standard 10^{-9} Option 05	184	$26,500
495P	100 Hz to 1.8 GHz	3 MHz to 10 Hz	−130 dBm	+30 to −130 dBm	Full	90 dB		184	$29,950
496	1 kHz to 1.8 GHz	1 MHz to 30 Hz	−126 dBm	+30 to −126 dBm		80 dB	±(5 MHz +2% Span)	190	$32,950
496P	1 kHz to 1.8 GHz	1 MHz to 30 Hz	−126 dBm	+30 to −126 dBm		80 dB	±(5 MHz +2% Span)	190	$32,950

490 SERIES COMMON CHARACTERISTICS

AMPLITUDE

Vertical Display Modes—10 dB/div, 2 dB/div and linear via pushbutton; any integer from 1 to 15 dB/div via Data Entry keypad.

Reference Level Range—Log Mode: −117 to +40 dBm (+30 dBm maximum); −130 to +27 dBV (+17 dBV maximum); −70 to +87 dBmV (+77 dBmV maximum); −10 to +147 dBμV (+137 dBμV maximum).

Linear Mode: 39.6 nV/div to 2.8 V/div (1 W or 10 V peak maximum.)

Reference Level Range (494A/494AP and 495/495P only)—Log Mode: −117 to +50 dBm (+30 dBm maximum); −130 to +37 dBV (+17 dBV maximum); −70 to +97 dBmV (+77 dBmV maximum); −10 to +157 dBμV (+137 dBμV maximum).

Linear Mode: 39.6 nV/Div to 2.8 V/Div (1 W or 10 V_{peak} maximum).

Reference Level Steps—10 dB coarse, 1 dB fine in 10 dB log; 1 dB coarse, 0.25 dB fine in 2 dB log; 1-2-5 sequence coarse, 1 dB equivalent fine in linear; coarse step = Log/Div (except 1 dB for 2 dB/Div), fine is 1 dB for ≥5 dB/Div or 0.25 dB for ≤4 dB/Div, set via Data Entry keypad.

Reference Level Accuracy—Accuracy is dependent on a combination of RF Attenuator Accuracy, IF Gain Accuracy, Resolution Bandwidth, Display Mode, Calibrator Accuracy, Frequency Response and Temperature Change (±0.15 dB/°C maximum).

Display Amplitude Accuracy—±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over 80 dB, (494A/494AP and 495/495P only: ±4 dB over 90 dB); ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over 16 dB range in 2 dB Log Mode; ±5% of full scale in LIN Mode.

RF Attenuator Range—0 to 60 dB in 10-dB steps.

RF Attenuator Accuracy, Step, 60-dB Range—DC to 1.8 GHz, 0.5 dB/10 dB, 3.0 dB maximum. 1.8 to 18 GHz, 1.5 dB/10 dB, 3.0 dB maximum. 18 to 21 GHz, 3.0 dB/10 dB, 6.0 dB maximum.

Resolution Filter Gain Variation—< ±0.4 dB after CAL with respect to 1-MHz filter (3 MHz filter on the 494A/494AP and 495/495P).

IF Gain Range—87 dB increase, 10 dB decrease (20 dB decrease on 494A/494AP and 495/495P) in MIN NOISE, 10 dB and 1-dB steps; 57.75 dB in 0.25-dB steps (Delta A mode).

IF Gain Accuracy—≤0.2 dB/dB to a maximum of 0.5 dB/9 dB except at the decade transitions −29 to −30 dBm, −39 to −40 dBm, −49 to −50 dBm, and −59 to −60 dBm which add an additional 0.5 dB for a maximum cumulative error of 1 dB/10 dB; ±2.0 dB maximum deviation over the 97 dB (107 dB on 494A/494AP and 495/495P) range.

Marker/s Accuracy—Equal to Reference Level Accuracy plus cumulative error of Display Amplitude Accuracy.

DISPLAY CHARACTERISTICS

CRT—8×10 cm, GH (P31) phosphor.

CRT Readout—Displays: Reference level, center frequency, marker frequency and amplitude, frequency range, vertical display mode, frequency span/div, resolution bandwidth, RF attenuation, video filter, and text.

Video Filter Range—0.3 Hz to 30 kHz (coupled to resolution filter by front panel pushbuttons).

Sweep—Triggered, auto, manual, single sweep, and external.

Sweep Time—20 μs to 5 s/div (10 s/div in Auto) in a 1-2-5 sequence; accuracy ±5%.

Triggering—Internal, External, Line, and Free Run; Internal Trigger Level ≥2 div of signal; external level ≥1 V peak, 15 Hz to 1 MHz, 50 V maximum (dc + ac peak).

Digital Storage—1000 points Horizontal, 250 points Vertical; A and B Views; Save A; Max Hold; B to Save A; digital averaging (Peak/Average); Pulse Stretcher.

Nonvolatile Display Memory—Store and recall up to 9 full waveforms complete with CRT readouts.

OUTPUT SIGNALS

Calibrator (Cal Out)—−20 dBm ±0.3 dB at 100 MHz ±REF Error.

1st and 2nd LO—Provides access to the output of the respective local oscillators. 1st LO output range +6 to +20 dBm; 2nd LO output range −22 to +15 dBm; these ports must be terminated in 50 Ω at all times.

Vertical Output—Provides 0.5 V ±5% of signal/div of video above and below the CRT centerline; 1 kΩ source impedance.

Horizontal Output—Provides 0.5 V either side of the CRT centerline. Full range ±2.5 V ±10%.

Pen Lift—TTL compatible, +5 V nominal to lift pen.

10 MHz IF Output—Output level is −5 dBm for a full screen signal at −30 dBm reference level; 50 Ω nominal impedance.

110 MHz IF Output (Option 42)—Center frequency from 108.5 MHz to 111.5 MHz; 3 dB bandwidth >5 MHz; Bandpass ripple ≤0.5 dB; power out with −30 dBm reference level and a full screen signal ≤0 dBm; 1 dB compression at ≥0 dBm output, MIN DISTORTION; 50 Ω nominal impedance.

Probe Power—Provides operating voltages for active probes. Pin 1: +5 V at 100 mA maximum. Pin 2: Ground. Pin 3: −15 V at 100 mA maximum. Pin 4: +15 V at 100 mA maximum.

IEEE STANDARD 488 (GPIB) CHARACTERISTICS

P Version—In accordance with IEEE Standard 488-1978 implemented as SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, and C0.

Non-P Versions (Plotter Output)—Implemented as SH1, AH0, T3, L0, SR0, RL0, PP0, DC0, DT0, and C0. (Excluding 492A and 496.)

GENERAL

Input Voltage—90 to 132 V ac or 180 to 250 V ac, 48 to 440 Hz.

Power—210 W maximum with all options, at 115 V and 60 Hz.

Configuration—Portable: 6.9×12.87×19.65 inches (175×327×499 mm) without front cover, handle, or feet.

ENVIRONMENTAL

Meets MIL-T-28800C, Type III, Class 3, Style C specifications as follows.

Temperature—Operating: −15 to +55°C. Nonoperating: −62 to +85°C.

Humidity—Operating: 95% (+5%, −0%) relative humidity. Nonoperating: Five cycles (120 hours) in accordance with MIL-STD-810D Procedure 3 (modified).

Altitude—Operating: 15,000 feet (tested to 25,000 feet). Nonoperating: 40,000 feet (tested to 50,000 feet).

Vibration—Operating: 15 to 55 Hz at 4 g maximum per MIL-STD-810D, Method 514, Procedure I (modified).

Shock—Operating and Nonoperating: 30 g, one-half sine, 11 ms (tested to 50 g).

Transit Drop—Free fall, 12 inches, one per each of six faces and eight corners.

Electromagnetic Compatibility—Meets requirements of MIL-STD-461B Part 4 tested as follows:

Conducted Emissions: CE01, 1 to 15 kHz only; CE03, 15 to 50 kHz relaxed by 15 dB.

Conducted Susceptibility: CS01; CS02; CS06.

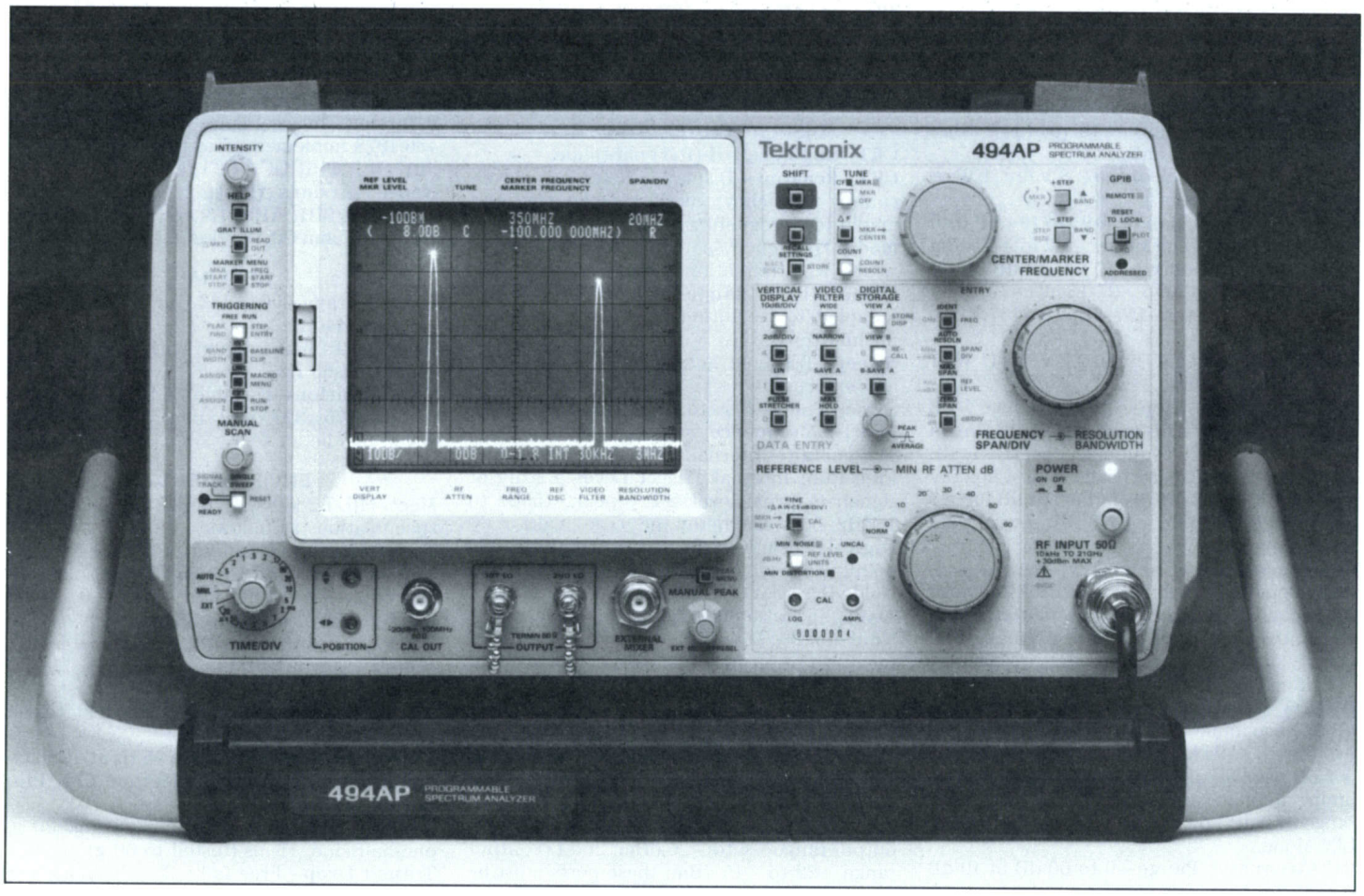
Radiated Emissions: RE01, Relaxed by 10 dB for fundamental to the 10th harmonic of power line (exceptioned, 30 to 36 kHz); RE02.

Radiated Susceptibility: RS01; RS02, to 5 A only; RS03, up to 1 GHz.

PORTABLE TO RACK ADAPTOR

Those needing the utility of a rackmounted instrument and desiring easy convertibility to a rugged portable should order the rack adaptor P/N 016-0844-00.

TOP-OF-THE-LINE PERFORMANCE IN THE 494A/494AP PORTABLE SPECTRUM ANALYZERS



NEW 494A/494AP

GPIB IEEE-488 The 494A and 494AP comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Covers 10 kHz to 325 GHz, −134 dBm Sensitivity**
- **90 dB Dynamic Range with 10 Hz to 3 MHz Resolution**
- **Marker and Center Frequency Accuracy up to 10^{-9}, Precision Signal Counter and External Reference Input**
- **Macro Programming Saves Frequently Used Measurement Programs in Nonvolatile Instrument Memory**
- **Intelligent Markers with Signal Processing Functions**
- **Pushbutton Occupied Bandwidth and Noise Normalization Functions**
- **Nonvolatile Memory for up to Nine Waveforms and Ten Front-Panel Settings**
- **Preselection and Multiband Sweep Coverage from 1.7 to 21 GHz**
- **HELP Mode Explains Front-Panel Controls and Signal Processing Functions at the Touch of a Button**
- **MATE/CIIL Compatibility for Air Force System Integration (Optional)**
- **Plot Data Directly Without a Controller**

Lab Quality Performance in Portable and Easy-to-Use Packages

Tektronix 494A/AP Spectrum Analyzers offer features essential for lab-grade measurements in a lightweight, portable package. Offering frequency coverage from 10 kHz to 325 GHz, with an impressive −134 dBm sensitivity and advanced, intelligent markers with exclusive signal processing capabilities, these analyzers are optimized for use in baseband through millimeter wave measurements, where ability to identify and process signal frequencies and amplitudes over wide dynamic ranges is critical.

Let the 494AP Make the Measurements for You

Downloadable programming capability (494AP only) lets you execute your frequently used measurement routines from the spectrum analyzer's nonvolatile memory. Tedious and often incorrect conversions from dBm to dBmV, dBV, dBμV, or dB/Hz reference units are no longer required since the 494A/AP handles it all for you. In addition, both analyzers can store up to 10 complete instrument setups in nonvolatile RAM for recall at the touch of a few buttons.

An internal high stability reference provides marker or center frequency accuracy approaching 10^{-9} for added confidence in measurements. *A built-in signal counter with 144 dB dynamic range means* you can determine the exact frequency of marked signals only 10 Hz apart—or count the exact delta frequency between two marked signals—even with greatly differing amplitudes. You also have the flexibility of tying in with a system clock, using the instrument's external reference lock capacity.

A permanent record of CRT displays can be obtained at the push of a button, without a controller, using the direct plot capability.

Menu-Selected, Intelligent Markers and Signal Processing

New dynamic markers automatically update frequency and amplitude data with every sweep. When used in conjunction with the 494A/AP's powerful signal processing intelligence you can use PULSE mode to mark the peak of a main lobe and peaks of side lobes at the push of a button. CW mode locates signals exhibiting CW characteristics and ignores all other signals. SPUR mode marks all signals that meet user-defined or automatic threshold criteria (Threshold criteria are available for all signal processing modes.)

The 494A/AP also offers hands-off convenience for measuring the bandwidths of filters, amplifiers, and other networks. Simply enter the desired bandwidth point, select Bandwidth mode and markers automatically update to display the new value.

To assist the new, non-technical, or infrequent operator in the use of this sophisticated spectrum analyzer with minimum training and supervision, the 494A/AP includes a HELP mode. HELP is a manual contained in ROM offering descriptions of all the controls and functions in plain English.

Switch Selectable 50 and 75 Ω Impedances (Option 07) Add Versatility

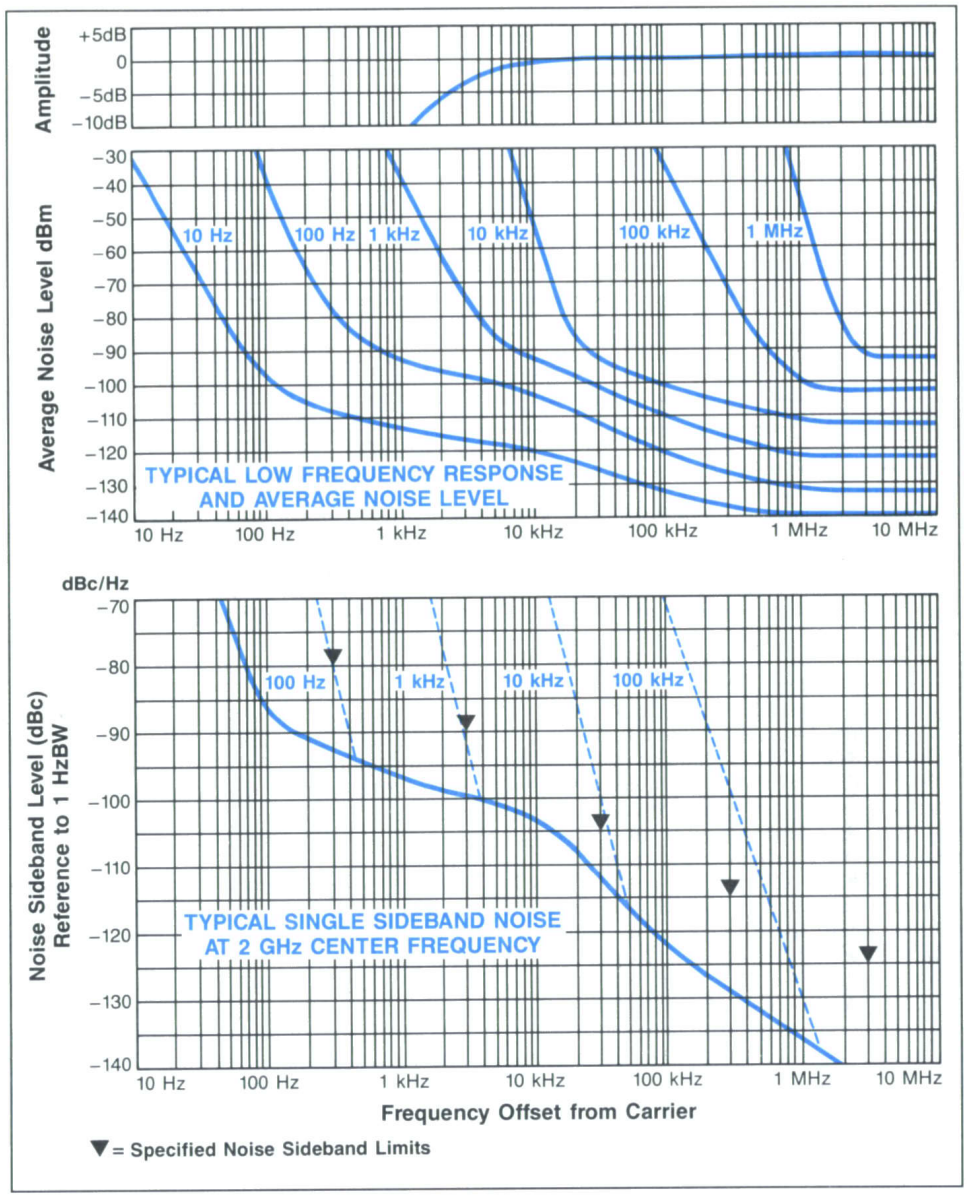
For applications such as CATV measurements, 75 Ω/dBmV greatly simplifies spectrum analysis. You no longer need to manually convert dBm to dBmV units or make measurement adjustments for external 50 to 75 Ω transformers. Option 07 also provides a 300 kHz resolution bandwidth filter optimized for VHF/UHF measurement.

Fully Automated Spectrum Analysis

The 494AP, the GPIB-programmable version of the 494A, simplifies processing and ensures measurement repeatability. You can operate the 494AP under program control, change front-panel settings, read data from the CRT display, and send waveforms from internal memory to other GPIB devices. Tek's *Standard Codes and Formats* keep commands clear, consistent, and universally understood.

You can increase programming flexibility and power with the 494AP's MATE/CIIL language extension (Option 45). It provides direct memory access for high-speed data transmission, a requirement for MATE/CIIL compliance.

To meet budget constraints or future applications, you can add full programmability to a standard 494A at any time. Your Tek Service Center is eager to assist when you are ready to convert.



CHARACTERISTICS

The following characteristics apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range—10 kHz to 21 GHz in coax, 18 GHz to 325 GHz in external waveguide mixers.

Center and Marker Frequency Accuracy—±[20%D + (F × REF) + (2N + 25) Hz] with Span/Div ≤200 kHz for Bands 1 & 5-12 or Span/Div ≤100 kHz for Bands 2-4 (phase locked); Otherwise (unlocked) ±[20%D + (F × REF) + (15N) kHz].

Where: D = Span/Div or Resolution BW, whichever is greater.
F = Center or Marker Frequency.
N = Harmonic Mixing Number.
REF = Reference Frequency Error.

Delta Marker Frequency Accuracy—±1% of Total Span.

Frequency Drift (After 1-hour Warm-up)—Span/Div ≤200 kHz for Bands 1 & 5-12 or Span/Div ≤100 kHz for Bands 2-4 (Phase locked): Drift rate ≤50 Hz/min. Correction will occur at the end of sweep. (Drift rate is typically <20 Hz/min after 1-hour warm-up from 25 °C storage.)

Span/Div >200 kHz for Bands 1 & 5-12 or Span/Div >100 kHz for Bands 2-4 (unlocked): Drift rate <(5 kHz)N/min (typically <(25 kHz)N/min after 30-minute warm-up).

Frequency Readout Resolution—≤10% of Span/Div to 1 Hz minimum.

Reference Frequency Error (Internal)—$\leq 1\times10^{-9}$ per day; $\leq 1\times10^{-7}$ in the first six months, $\leq 1\times10^{-7}$ per year thereafter; Accuracy 30 minutes after power on within 5×10^{-8} of the

SENSITIVITY AND FREQUENCY RESPONSE

Band and Frequency Range	Harmonic Number	Sensitivity (dBm) at Minimum Resolution	Frequency Response (dB)*1
1 (10 kHz-1.8 GHz)	1	−134	±1.5
2 (1.7-5.5 GHz)	1	−125	±2.5
3 (3.0-7.1 GHz)	1	−125	±2.5
4 (5.4-12 GHz) 12.0-18.0 GHz	3	−111 −107	±3.5
5 (15-21 GHz)	3	−107	±5.0
6 (18-27 GHz)	6	−116	±2.0
7 (26-40 GHz)	10	−111	±2.0
8 (33-50 GHz) 40-60 GHz	10	−111	±2.0 ±2.5
9 (50-90 GHz)*2	15	−105 at 50 GHz; −95 at 90 GHz	±3.0
10 (75-140 GHz)*2	23	−100 at 75 GHz; −85 at 140 GHz	±3.0
11 (110-220 GHz)*2	37	−90 at 110 GHz; −75 at 220 GHz	±3.0
12 (170-325 GHz)*2	56	−70 at 170 GHz; −55 at 325 GHz	±3.0

*1 *Measured with 10 dB RF Attenuation and peaking optimized. Frequency response is within ±4.5 dB from 10 kHz to 18 GHz.*

*2 *Frequency response for any 5-GHz band. Response is within ±6 dB referenced to 100 MHz.*

frequency after 24 hours; Within 2×10^{-8} over the temperature range of −15 to +55 °C.

Signal Counter Accuracy—±[(F × REF) + (5 + N) Hz + 1 LSD].

Where: F = Center or Marker Frequency.
REF = Reference Frequency Error.
N = Harmonic Mixing Number.
LSD = Least Significant Digit.

Counter Sensitivity—Signal level must be ≥20 dB above the average noise level and within 60 dB of the reference level.

Counter Readout Resolution—Selectable from 1 Hz to 1 GHz in decade steps.

Residual FM—≤(5 + N) Hz peak-to-peak in 20 msec, Span/Div ≤200 kHz for Bands 1 & 5-12 or Span/Div ≤100 kHz for Bands 2-4 (Phase locked); Otherwise ≤(7 kHz) N peak-to-peak in 20 msec (unlocked).

Resolution Filters—10 Hz to 3 MHz; 10 Hz to 1 MHz in decade steps; 6 dB bandwidth ±20%; Shape factor ≤7.5:1 except 10 Hz where 60 dB BW ≤150 Hz.

Frequency Span/Division—0 Hz (ZERO SPAN pushbutton, knob or keypad data entry); 10 Hz to 10 GHz (in a 1-2-5 sequence) via Span/Div knob; 10 Hz to 15 GHz (to two significant digits) via FREQUENCY or MARKER START/STOP, or keypad data entry; 180 MHz via power-up or RESET: Full band via Knob or MAX SPAN pushbutton; Multiband spans in Bands 2-5 (1.7 to 21 GHz) via START/STOP FREQUENCY mode; accuracy ±5% for Span/Div ≥50 Hz, ±10% for Span/Div <50 Hz.

Frequency Response—See chart above.

AMPLITUDE RELATED

See 490 Series Family Specifications on page 179 for additional amplitude related details.

Noise Sidebands (N=1)

dBc/Hz	Offset from Carrier
−80	300 Hz
−90	3 kHz
−105	30 kHz
−115	300 kHz
−125	3 MHz

Power Line Relted Sidebands—≤−55 dBc for line frequencies from 47 to 440 Hz.

Display Dynamic Range—90 dB Log mode; 8 divisions Linear mode.

Third Order Intermodulation Distortion—≤−70 dBc for any two on-screen CW signals within any frequency span in MIN DISTORTION mode: ≤−100 dBc for signals spaced ≥100 MHz in Bands 2-5.

Harmonic Distortion—≤−60 dBc, ≤−100 dBc for Bands 2-5, for a −40 dBm CW signal with 0 dB RF Attenuation in MIN DISTORTION mode.

Sensitivity (Equivalent Input Noise)—See chart above.

Residual Responses—≤−100 dBm with input terminated and 0 dB RF Attenuation.

LO Emissions—≤−70 dBm with 0 dB RF Attenuation.

TIME RELATED

Sweep Time—20 μs to 5 s/div (10 s/div in Auto) in a 1-2-5 sequence; accuracy ±5%.

Marker Time Accuracy—±10% (indicates time from start of sweep).

Δ Marker Time Accuracy—±5% (indicates time between two markers).

INPUT

RF Input—Type "N" female, 50 Ω nominal impedance.

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
10 kHz to 2.5 GHz	1.3:1 Max; 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max; 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max; 1.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max; 2.7:1 Typical	3.0:1

Maximum Safe Input (0 dB RF Attenuation)—+30 dBm (1 W) continuous, 75 W peak, 1 μsec pulsewidth, 0.001 duty; 0 V dc.

1 dB Gain Compression—−10 dBm with 0 dB RF Attenuation in MIN NOISE; −20 dBm with 0 dB RF Attenuation in MIN DISTORTION.

External Mixer Input—Front-panel TNC female connector for IF frequency inputs from external mixers covering up to 325 GHz.

External Reference Input—Frequency: 1, 2, 5, or 10 MHz with ≤5 ppm stability.
Power Range: −15 to +15 dBm.
Waveshape: Sine wave, ECL, TTL (Allowable Duty cycle symmetry is 40 to 60%).
Input Impedance: 50 Ω ac, 500 Ω dc; Rear-panel BNC input.

Horizontal/Trigger Input—Rear-panel BNC female; Horizontal: dc coupled input, 0 to +10 V (dc + peak ac) for full screen sweep, selected in the EXT Position of the TIME/DIV control; Trigger: ac coupled, 1.0 V to 50 V (dc + peak ac), 15 Hz to 1 MHz, 30 V_{rms} ac derated linearly to 3.5 V_{rms} at 100 kHz and above; pulsewidth ≥0.1 μs.

Marker/Video Input—External Marker or video input switched by pin 1 of the accessories connector (J104); Video input 0 to +4 V; marker input 0 to −10 V (interfaces with Tektronix 1405 Sideband Adaptor).

GENERAL

Battery-Powered Memory—Nine instrument settings plus power-down settings, 9 full waveforms plus readouts; 8 Macros (P version only), frequency and amplitude calibration factors, 39 preselector peaks and 12 external band peaks are stored in nonvolatile RAM; Battery life ≥5 years at 25 °C, >1 year at 55 °C.

Weight—47 lbs. 14 oz. (21.8 kg) maximum including cover and standard accessories; Option 07 adds 7 oz. (0.2 kg).

Configuration—Portable; 6.9×12.87×19.65 inches (175×327×499 mm) without front cover, handle, or feet.

CHARACTERISTICS

50/75 Ω OPTION 07
75 Ω INPUT RELATED

Provides 75 Ω input and dBmV calibration in addition to the normal 50 Ω input and dBm calibration. The 100 kHz resolution filter is replaced by 300 kHz to optimize the instrument for broadcast and CATV uses.

Center Frequency Range—1 to 1000 MHz.

Frequency Response—±2.0 dB from 5 to 1000 MHz; Typical response for the 1 to 5 MHz frequency range is <3 dB down from the 5 MHz response.

Reference Level Range—−68 to +79 dBmV (+89 dBmV is achievable in MIN NOISE mode and +99 dBmV in Reduced Gain mode).

Sensitivity (Equivalent Input Noise)—5 to 1000 MHz—75 Ω Input

Sensitivity (dBmV)	Resolution Bandwidth
−85	10 Hz
−76	100 Hz
−66	1 kHz
−56	10 kHz
−41	300 kHz
−36	1 MHz
−31	3 MHz
50 Ω RF Input	
−90 (dBm)	300 kHz

Input Impedance—75 Ω; VSWR 1.35:1 (17 dB RL) maximum, 5 to 800 MHz; VSWR 1.6:1 (13 dB RL) maximum, 800 to 1000 MHz; BNC female.
Maximum Input Level—With 0 dB Attenuation: +78 dBmV, 100 V maximum (dc + ac peak).
Calibrator (Cal Out)—+20 dBmV ±0.5 dB; 75 Ω impedance nominal.
Portable to Rack adaptor—Those needing the utility of a rackmounted instrument and desiring easy convertibility to a rugged portable should order the rack adaptor P/N 016-0844-00.

SUMMARY OF SIGNAL PROCESSING AND MARKER FUNCTIONS

Assign Menu Functions: Marker functions that are assignable to nonvolatile front-panel pushbuttons ASSIGN 1 and ASSIGN 2 are listed as follows:

RIGHT NEXT: Moves marker to the right next signal defined by "SIGNAL TYPE" in frequency.

LEFT NEXT: Moves marker to the left next signal defined by "SIGNAL TYPE" in frequency.

NEXT LOWER: Moves marker to the next lower signal defined by SIGNAL TYPE" in amplitude.

NEXT HIGHER: Moves marker to the next higher signal defined by "SIGNAL TYPE" in amplitude.

MOVE RIGHT "X" dB: Moves marker to the right "X" dB (X can be + or −) in signal amplitude from its current position.

MOVE LEFT "X" dB: Moves marker to the left "X" dB (X can be + or −) in signal amplitude from its current position.

FIND PEAK AND CENTER: Marks the highest displayed signal and moves it to the center of the CRT screen.

Signal Type Menu: Sets the signal processor pattern recognition from a selection of three routines. Chosen signal type remains in memory until overwritten by new selection, RESET (which defaults to CW), or power down.

CW: Recognizes signals with CW characteristics—ignores all others (instrument selects this mode at power-up).

PULSE: Recognizes pulsed RF lobe patterns for line and dense spectrums—places marker at peaks—easy location of carrier spectral line.

SPUR: Recognizes *ALL* signals including impulses above the assigned Threshold.

Noise Normalization (dB/Hz): Normalizes the noise measured at the marked position to one Hertz—Simplifies Phase Noise and Signal/Noise Ratio tests.
Signal Track: Locates, marks, and centers on the highest signal on screen above the Threshold. If track is lost, or if the signal drops below Threshold value, "SIGNAL TRACK IDLE" will be displayed on the CRT below the last "tracked" frequency and the instrument will "idle" there until track is regained.

Peak Find: Locates and marks the highest displayed signal on the CRT.

Bandwidth: Places the markers the assigned number (from memory) of dB below, left, and right of the desired signal peak automatically after each sweep.

Marker to Reference Level: Changes reference level to the marker amplitude value.

Marker to Center: Changes center frequency to equal marker frequency.

Marker Start/Stop: Frequency start/stop sweep is matched to the current Δ marker position.
Step Size: Assigns either the center, marker, or Δ marker frequency to the ± STEP frequency functions.

Macro Menu (494AP only): Allows the selection from up to 8 stored user-defined programs to be executed.

Run/Stop (494AP only): Starts and stops execution of the selected Macro program.

Settings Store/Recall: Allows up to 9 full front-panel set-ups, plus a power-down last instrument state, to be stored and recalled from nonvolatile memory.

Zoom (494AP only): Moves the marked signal to center screen and decrements the span.

ORDERING INFORMATION

494A Spectrum Analyzer. **$43,700**
Includes: 50 Ω coax cable, N-to-N Conn, 6 ft (012-0114-00); 50 Ω coax cable, BNC-to-BNC Conn, 18 in. (012-0076-00); N Male-to-BNC female adaptor (103-0045-00); diplexer assembly, Options 21 and 22 (015-0385-00); 4 A Fast Blow fuses (159-0017-00); power cord (161-0104-00); power cord clamp (343-0170-00); CRT light filters (amber 378-0115-01, gray 343-0115-02); CRT mesh filter (378-0227-01); rear connector shield (337-3274-00); operator's manual (070-5557-00).
494AP Programmable Spectrum Analyzer. **$47,995**
Includes: Same as 494A plus programmer's manual (070-5559-00).

OPTIONS

Option 07—75 Ω input. **+$750**
Includes: BNC male-to-female adaptor connector (013-0126-00); 42-inch, BNC-to-BNC connector, 75 Ω coax cable (012-0074-00).
Option 21—18 to 40 GHz High Performance Waveguide Mixer Set. **+$2,650**
Includes: Diplexer assembly (015-0385-00); TNC-to-SMA adaptor (015-0388-00); SMA-to-SMA cable (012-0649-00); semirigid cable (015-1055-00).
Option 22—18 to 60 GHz High Performance Waveguide Mixer Set. **+$4,460**
Includes: Same as Option 21.
Option 39—Replaces Lithium with Silver batteries. **+$50**
Option 41—Digital Radio Enhancement. **+$450**
Option 42—110 MHz, >5 MHz bandwidth, IF Output. **+$1,500**
Option 45—MATE/CIIL language interface. **+$4,975**
Option 52*[1]—North American 220 V configuration with standard power cord.
Option B1—Service Manuals **+$50**
(Vol. 1) 070-5560-00.
(Vol. 2) 070-5561-00.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY PLUS SERVICE PLANS

See Service section.
Option M1—2 Calibrations.
(494A) **+$2,095**
(494AP) **+$2,120**
Option M2—2 Years Service.
(494A) **+$3,725**
(494AP) **+$3,770**
Option M3—2 Years Service and 4 Calibrations.
(494A) **+$4,185**
(494AP) **+$4,240**

OPTIONAL ACCESSORIES

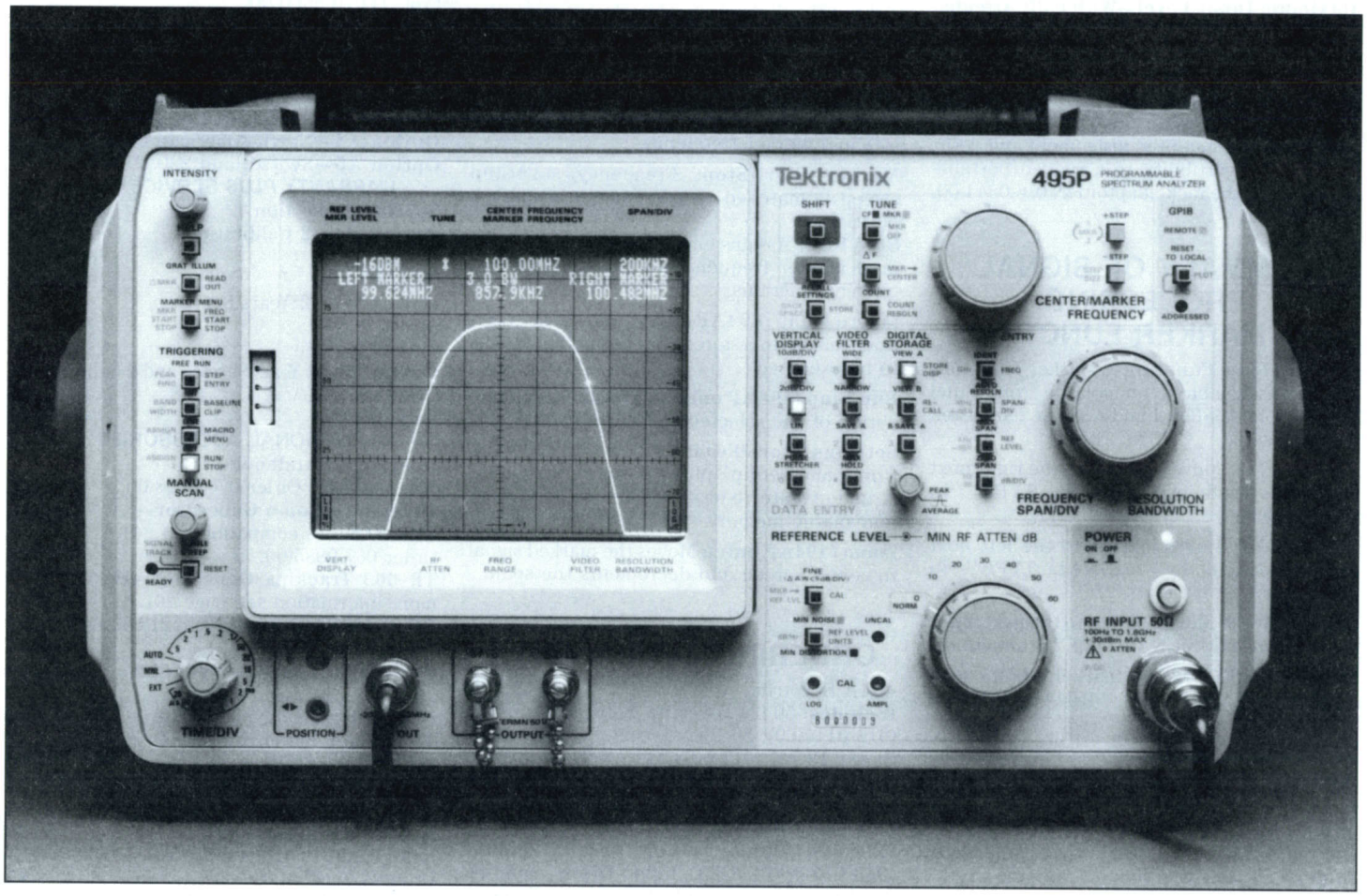
Operators Handbook—
(494A/494AP) Order 070-5558-00 **$10**
Microwave Comb Generator—
TM 500 Series compatible.
Order 067-0885-00. **$1,815**
TR 503 Tracking Generator—For more information see page 201. **$7,080**
DC Block N to N—10 kHz to 21 GHz.
Order 015-0509-00. **$250**
P6201 FET Probe to 900 MHz **$1,250**
1405 TV Sideband Adaptor—
525/60 Markers. See page 201. **$5,780**
TV Trigger Synchronizer—
Order 015-0261-01. **$450**
Cases—
(Hard Transit) Order 016-0658-00. **$795**
(Soft) Order 016-0659-00. **$130**
Rear Panel Protective Cover—
Order 337-3274-00. **$5**
Lab Cart—K213. **$625**
Camera—C-5C. **$495**

Note: 490-Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52, and C-53 cameras.

Portable to Rack Adaptor—
Order 016-0844-00. **$630**
GPIB Cable—Order 012-0630-01. **$95**

*[1] *To order, contact your local Tektronix Sales Office.*

NO COMPROMISE PERFORMANCE IN THE 495/495P PORTABLE SPECTRUM ANALYZERS



495/495P

Portable Spectrum Analyzers

GPIB IEEE-488 The 495P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Covers 100 Hz to 1.8 GHz With −130 dBm Sensitivity and ±1 dB Frequency Response**
- **10^{-9} Marker and Center Frequency Accuracy, Built-In Signal Counter, 90 dB Dynamic Range**
- **Front Panel Execution of Downloaded Programs With the 495P**
- **Intelligent Markers With Signal Processing Functions**
- **Pushbutton Occupied Bandwidth and Noise Normalization Functions**
- **Switch Selectable 50 and 75 Ω Impedances (Option 07) for IF, CATV and Local Area Network Applications**
- **HELP Mode Explains Front Panel Controls and Signal Processing Functions at the Touch of a Button**
- **Optional MATE/CIIL Compatibility**

Lab Quality Performance Made Fully Portable and Easy to Use

The Tektronix 495 Spectrum Analyzer offers features essential for lab-grade measurements in a lightweight, portable package. Offering frequency coverage from 100 Hz to 1.8 GHz, with an impressive −130 dBm sensitivity and advanced, intelligent markers with exclusive signal processing capabilities, the 495 is optimized for use in baseband through UHF measurements.

Macro Programming, 10^{-9} Frequency Accuracy, Signal Counting, and System Clock Compatibility

Downloadable programming capability (495P only) lets you execute frequently used measurement routines from the spectrum analyzer's nonvolatile memory. An internal high stability reference (Option 05) provides 10^{-9} marker or center frequency accuracy for added confidence in measurements. A built-in signal counter with 140 dB dynamic range means you can determine the exact frequency of marked signals only 10 Hz apart, or count the exact delta frequency between two marked signals, even with greatly differing amplitudes. With Option 05 you also have the flexibility of coupling to a system clock, using the instrument's external reference lock capacity.

Nonvolatile memory lets you store up to ten front panel settings and nine waveforms, simplifying setup and making field operation easier. A permanent record of CRT displays can be obtained at the push of a button, without a controller, using the direct plot capability.

Menu-Selected, Intelligent Markers and Signal Processing

New dynamic markers automatically update frequency and amplitude data with every sweep. In conjunction with the 495's powerful signal processing intelligence, you can use PULSE mode to mark the peak of a main lobe and peaks of side lobes at the push of a button. CW mode locates signals exhibiting CW character-

istics and ignores all other signals. SPUR mode marks signals that meet user-definable or automatic threshold criteria. Threshold criteria are available for all signal processing modes.

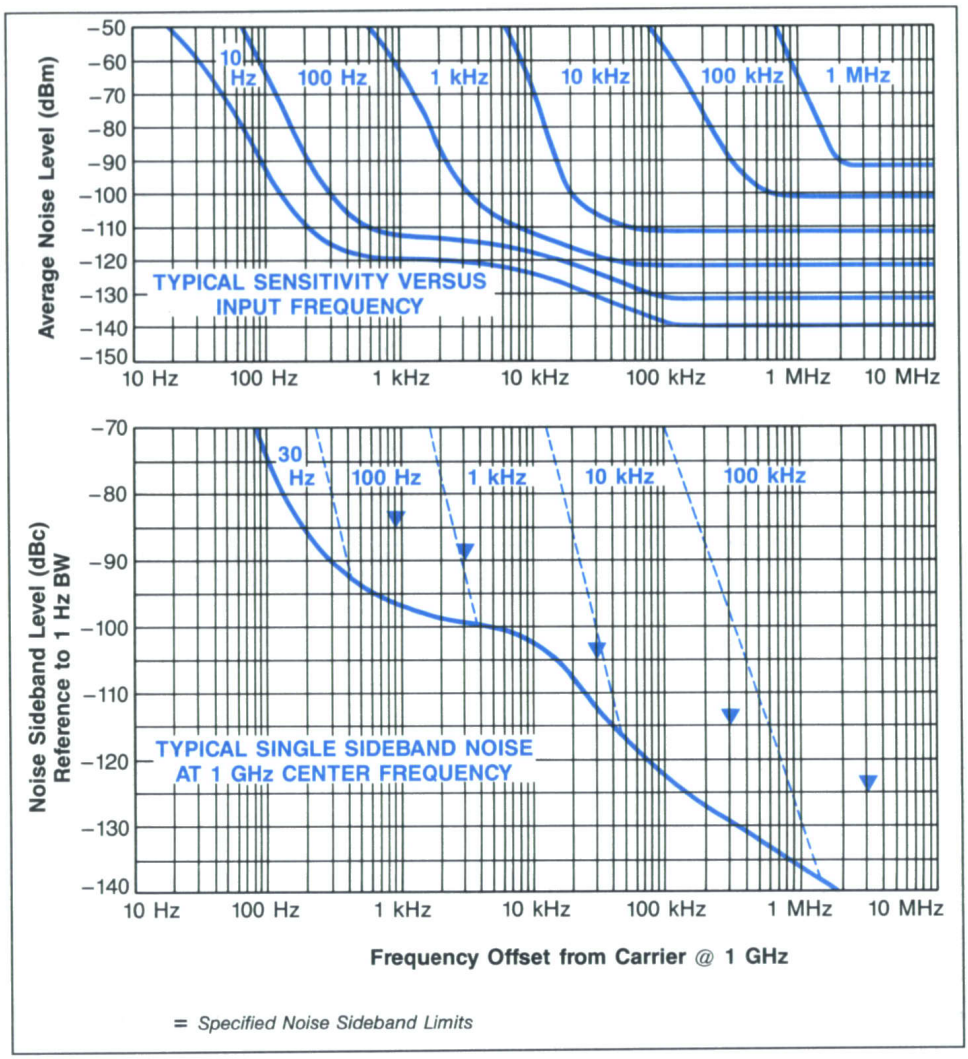
The 495 also offers hands-off convenience for measuring the bandwidths of filters, amplifiers and other networks. Simply enter the desired bandwidth point, select Bandwidth mode, and markers automatically update to display the new value.

To assist the new, nontechnical, or infrequent operator in using this sophisticated spectrum analyzer, with a minimum of training and supervision, the 495 includes a HELP mode. Contained in ROM, it offers descriptions of controls and functions in plain English.

Switch Selectable 50 and 75 Ω Impedances (Option 07) Add Versatility
For applications such as CATV measurements, 75 Ω/dBmV greatly simplifies spectrum analysis. You no longer need to manually convert dBm to dBmV units or make measurement adjustments for external 50 to 75 Ω transformers. Option 07 also provides a 300 kHz resolution bandwidth filter optimized for VHF/UHF measurements.

Fully Automated Spectrum Analysis
The 495P is the GPIB-programmable version of the 495. It simplifies programming and ensures measurement repeatability. You can operate the 495P under program control, change front-panel settings, read data from the CRT display, and send waveforms from internal digital storage memory to other GPIB devices. Tek's *Standard Codes and Formats* keep commands clear, consistent, and universally understood.

There are many other time-saving and accuracy-enhancing capabilities. See the summary of signal processing and marker functions on page 183 for a more complete idea of the 495 measurement benefits. Talk to your Tektronix Spectrum Analyzer Sales Engineer for complete details.



CHARACTERISTICS

The following characteristics apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range—100 Hz to 1.8 GHz.

Center and Marker Frequency Accuracy—±[20%D +(F × Ref. Freq. Error) + 15 Hz] with span/div ≤200 kHz (Phase locked); ±[20%D + (F × Ref. Freq. Error) + 15 kHz] with span/div >200 kHz (unlocked).
Where: D = Span/div or Resolution BW, whichever is greater.
F = Center or Marker Frequency.

Reference Frequency Error (Internal)—$\leq 1\times10^{-9}$ per day; $\leq 1\times10^{-7}$ in the first six months, $\leq 1\times10^{-7}$/year thereafter; Accuracy 30 minutes after power on within 5×10^{-8} of the frequency after 24 hours; Within 2×10^{-8} over the temperature range of −15 to +55 °C.

Signal Counter Accuracy—±[(F × Ref. Freq. Error) +5 Hz +1 LSD]
Where: F = Center, Marker, or Delta Marker Frequency
LSD = Least Significant Digit

Counter Sensitivity—Signal level must be ≥20 dB above the average noise level and within 60 dB of the reference level.

Counter Readout Resolution—Selectable from 1 Hz to 100 MHz in decade steps.

External Reference Input—Frequency: 1,2,5, or 10 MHz with ≤5 ppm stability. Power Range: −15 to +15 dBm. Waveshape: Sine wave, ECL, TTL (Allowable Duty cycle symmetry is 40 to 60%). Input Impedance: 50 Ω ac, 500 Ω dc; Rear-panel BNC input.

Delta Marker Frequency Accuracy—±1% of Total Span.

Frequency Drift (After 1-Hour Warm-Up)—Span/div ≤200 kHz (Phase Locked): Drift rate ≤50 Hz/min. Correction will occur at the end of sweep for sweep times ≥5 s/div. (Drift rate is typically <20 Hz/min after 1 hour warm-up from 25 °C storage). Span/div >200 kHz (unlocked): Drift rate <5 kHz/min (typically <25 kHz/min after 30 minute warm-up); $\leq 1\times10^{-5}$ over the temperature range of −15 to +55 °C without Option 05.

Frequency Readout Resolution—≤10% of span/div to 1 Hz minimum.

Residual FM—≤5 Hz peak-to-peak in 20 msec, span/div ≤200 kHz (Phase locked); ≤7 kHz peak to peak in 20 msec, span/div >200 kHz (unlocked).

Resolution Filters—10 Hz to 1 MHz in decade steps and 3 MHz (6 db bandwidth ±20%); Shape factor ≤7.5:1 except 10 Hz where 60 dB BW ≤150 Hz.

Frequency Span/Division—0 Hz (ZERO SPAN pushbutton or keypad data entry); 10 Hz to 100 MHz (in a 1-2-5 sequence) via span/div knob; 10 Hz to 170 MHz (to two significant digits) via FREQUENCY or MARKER START/STOP, or keypad data entry; 180 MHz via power-up, RESET, or MAX SPAN pushbuttons; accuracy ±5% (±10% <50 Hz/div).

Frequency Response—±1.0 dB (measured with 10 dB RF attenuation).

Zero Frequency Spur—−24 dBm maximum measured into 50 Ω and open circuit with 0 dB RF attenuation; −35 dBm typical.

Power Line Related Sidebands—≤−55 dBc for line frequencies from 47 to 440 Hz.

AMPLITUDE RELATED

See 490 Series Family Specifications on page 179 for additional amplitude related details.

Display Dynamic Range—90 dB Log mode; 8 divisions Linear mode.

Noise Sidebands

dBc/Hz	Offset from Carrier
−80	300 Hz
−90	3 kHz
−105	30 kHz
−115	300 kHz
−125	3 MHz

Residual Responses—≤ −100 dBm with input terminated and 0 dB RF attenuation.
Harmonic Distortion—≤ −60 dBc for a −30 dBm CW signal with 0 dB RF attenuation in MIN DISTORTION mode.
Third Order Intermodulation Distortion—≤ −70 dBc for any two on-screen CW signals within any frequency span in MIN DISTORTION mode.

Sensitivity (Equivalent Input Noise)—

Sensitivity dBm	Resolution Bandwidth
−130	10 Hz
−125	100 Hz
−115	1000 Hz
−105	10 kHz
−95	100 kHz
−85	1 MHz
−80	3 MHz

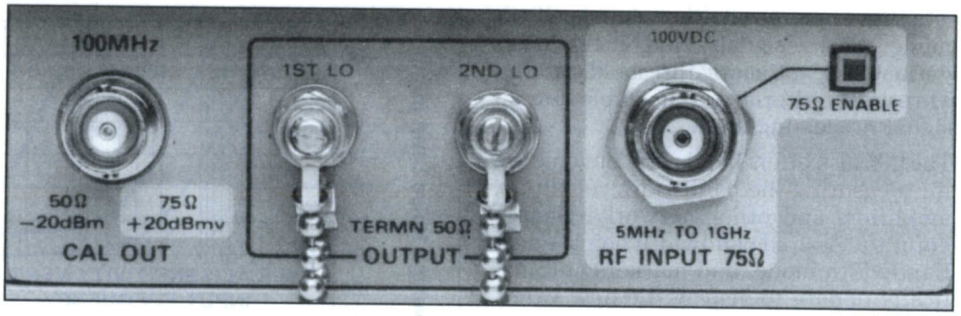
INPUT SIGNAL

RF Input—Type "N" female, 50 Ω nominal impedance.
VSWR—1.3:1 maximum, 1.2:1 typical, with 10 dB or more RF attenuation; 2.0:1 maximum, 1.9:1 typical, with 0 dB attenuation.
Maximum Safe Input (0 dB RF Attenuation)—+30 dBm (1 W) continuous, 75 W peak, 1 μ sec pulse width, 0.001 duty; 0 V dc.
1 dB Gain Compression—−10 dBm with 0 dB RF attenuation in MIN NOISE; −20 dBm with 0 dB RF attenuation in MIN DISTORTION; (No gain compression can be observed on screen).
LO Emissions—≤ −70 dBm with 0 dB RF attenuation.

CHARACTERISTICS

50/75 Ω OPTION 07
75 Ω INPUT RELATED

Provides 75 Ω input and dBmV calibration in addition to the normal 50 Ω input and dBm calibration. The 100 kHz resolution filter is replaced by 300 kHz to optimize the instrument for broadcast and CATV uses.
Center Frequency Range—1 to 1000 MHz.
Frequency Response—±2.0 dB from 5 to 1000 MHz; Typical response for the 1 to 5 MHz frequency range is <3 dB down from the 5 MHz response.
Reference Level Range—−68 dBmV to +79 dBmV (+89 dBmV is achievable in MIN NOISE mode and +99 dBmV in Reduced Gain mode).



Input Impedance—75 Ω; VSWR 1.35:1 (17 dB RL) maximum, 5 to 800 MHz; VSWR 1.6:1 (13 dB RL) maximum, 800 to 1000 MHz; BNC female.
Maximum Input Level—With 0 dB Attenuation: +78 dBmV, 100 V maximum (dc + ac peak).
Calibrator (Cal Out)—+20 dBmV ±0.5 dB; 75 Ω impedance nominal.

Sensitivity (Equivalent Input Noise)—75 Ω Input (5 to 1000 MHz)

Sensitivity (dBmV)	Resolution Bandwidth
−81	10 Hz
−76	100 Hz
−66	1000 Hz
−56	10 kHz
−41	300 kHz
−36	1 MHz
−31	3 MHz
50 Ω RF Input	
−90 (dBm)	300 kHz

ORDERING INFORMATION

495 Spectrum Analyzer **$26,500**
Includes: 50-Ω coax cable, N-to-N Conn, 6 ft (012-0114-00); 50-Ω coax cable, BNC-to-BNC Conn, 18 in. (012-0076-00); operator's manual, Vol. 2 (070-5085-00); N male-to-BNC female adaptor (103-0045-00); 4 A fast blow fuses (159-0017-00); power cord (161-0104-00); power cord clamp (343-0170-00); CRT light filters (amber 378-0115-01, gray 343-0115-02); CRT mesh filter (378-0227-01); rear connector shield (337-3274-00).
495P Programmable Spectrum Analyzer **$29,950**
Includes: Same as 495 plus programmer's manual (070-5086-00).

OPTIONS

Option 05—Precision Reference **+$83,000**
Option 07—75 Ω input. **+$750**
Includes: BNC male-to-female adaptor connector (013-0126-00); 42 inch, BNC-to-BNC connector, 75 Ω coax cable (012-0074-00).
Option 39—Replaces Lithium with Silver batteries. **+$50**
Option 42—110 MHz, >5 MHz bandwidth, IF Output. **+$1,500**
Option 45—MATE/CIIL language interface. **+$4,975**
Option 52[*1]—North American 220 V configuration with standard power cord.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY PLUS SERVICE PLANS

See Service section.
Option M1—2 Calibrations.
(495) **+$1,735**
(495P) **+$1,810**
Option M2—2 Years Service.
(495) **+$2,875**
(495P) **+$3,015**
Option M3—2 Years Service and 4 Calibrations.
(495) **+$3,470**
(495P) **+$3,620**

OPTIONAL ACCESSORIES

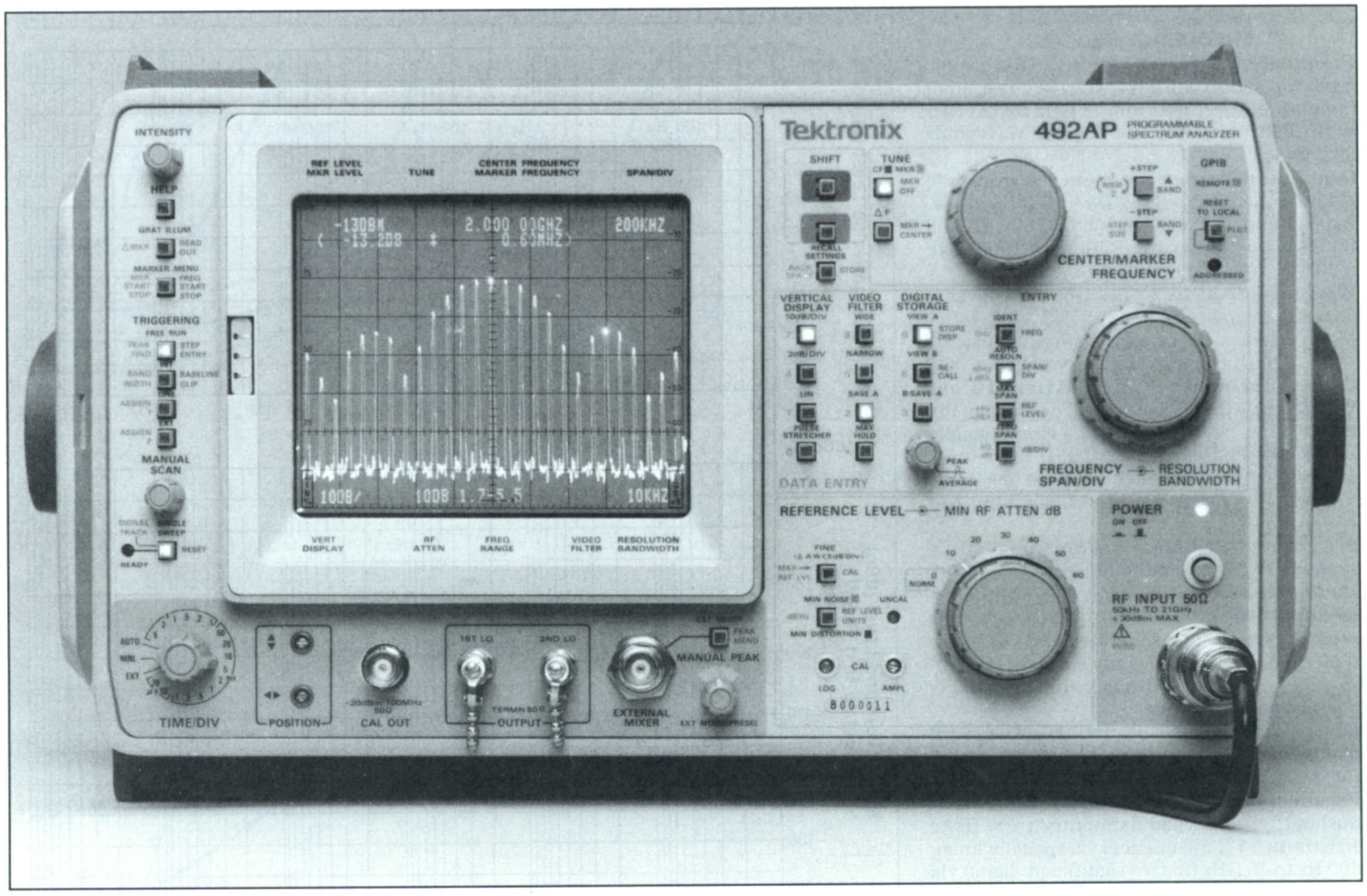
TR 503 Tracking Generator—For more information see page 201. **$7,080**
75 to 50 Ω Power Splitter—Order 067-1232-00. **$250**
75 to 50 Ω Minimum Loss Attenuator—Order 011-0112-00. **$60**
DC Block N to N—Order 015-0509-00. **$250**
P6201 FET Probe to 900 MHz. **$1,250**
1405 TV Sideband Adaptor—525/60 Markers. See page 201. **$5,780**
TV Trigger Synchronizer—Order 015-0261-01. **$450**
Cases—
(Hard Transit) Order 016-0658-00. **$795**
(Soft) Order 016-0659-00. **$130**
Rear Panel Protective Cover—Order 337-3274-00. **$5**
Lab Cart—K213. **$625**
Camera—C-5C. **$495**

Note: 490-Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52, and C-53 cameras.

Portable to Rack Adaptor—Order 016-0844-00. **$630**

[*1] *To order, contact your local Tektronix Sales Office.*

WITH ITS BUILT-IN MARKER INTELLIGENCE YOU CAN RELY ON THE 492A AS A DECISION-MAKING TOOL



492A/492AP

Spectrum Analyzers

GPIB IEEE-488

The 492AP complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Dot Markers Accurate in Frequency to 10^{-5}**
- **Frequency Range From 50 kHz to 325 GHz**
- **CW, Pulse, and Spurious Signal Processing Modes**
- **Occupied Bandwidth Function**
  - **— dBm, dBV, dBmV, and dBμV Alternate Reference Units**
  - **— Signal Tracking**
  - **— Noise Normalization**
- **Keypad Entry of Frequency, Span/Div, Reference Level and Vertical Scale Factors**
- **Environmentalized per MIL-T-28800C Type III, Class 3, Style C**

Convenience, Accuracy, Intelligence, and Value

The 492A and the fully programmable 492AP represent the benchmark for spectrum analyzers with built-in signal processing intelligence. These spectrum analyzers are designed to offer power to the experienced user, yet offer convenience to the novice, in field environments and in the lab. These lightweight, portable form factor spectrum analyzers deliver maximum utility and benefits at a reasonable cost.

Counter Center Frequency Accuracy, Near Zero Long-Term Drift, Superior Range and Resolution All in One Package

The 492A offers calibrated amplitude and frequency coverage from 50 kHz to 21 GHz in coax, and to 325 GHz using Tek's WM 490 Series high performance waveguide mixers.

Center frequency accuracy is excellent; typically 1 kHz at 100 MHz, 10 kHz at 10 GHz and 40 kHz at 40 GHz. Negligible long term frequency drift ensures measurement repeatability.

You get 100 Hz resolution bandwidth to 220 GHz and 1 kHz resolution to 325 GHz with high sensitivity and low phase noise—plus built-in preselection to 21 GHz (Option 01).

Menu-Selectable Signal Processing

Enables the analyzer to mark the peak of a main lobe and the peaks of side lobes at the push of a button—using the pulsed RF signal processing mode in conjunction with other marker functions like Peak Find, Right Next, and Left Next. The CW mode will mark only signals exhibiting CW characteristics with regard to span and resolution, ignoring all other signals. The spur mode will locate all signals that meet user-definable or automatic threshold criteria. Threshold criteria are available for all signal processing.

CHARACTERISTICS

The following characteristics apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range—50 kHz to 21 GHz coaxial input; 50 kHz to 325 GHz external mixer input (amplitude specified from 18 GHz to 325 GHz with Tektronix WM 490 Series Waveguide Mixers).

Center and Marker Frequency Accuracy*1—Phase Locked: $\pm[20\%D + (F\times10^{-5})]$ Hz. Bands 1 and 5-12 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz. Unlocked: $\pm20\%D + (F\times10^{-5}) + (15\text{ kHz})N]$ Hz.

Where: D=Span/div or Res BW, whichever is greater.
F=Center or Marker Frequency
N=Harmonic Mixing Number

Center Frequency Drift (After 1-Hour Warm-Up)—Bands 1 and 5-12 with span/div ≤200 kHz, and bands 2-4 with span/div ≤100 kHz. Phase locked: ≤50 Hz per minute of sweep time corrected at least every 30 seconds. Unlocked: ≤(5 kHz) N per minute of sweep time.

Frequency Readout Resolution—≤10% span/div to 1 kHz minimum (100 Hz in Delta Marker Mode).

Residual FM—Phase Locked: ≤(10 +2N) Hz peak-to-peak in 20 ms, Bands 1 and 5-12 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz. Unlocked: ≤(7 kHz) N peak-to-peak in 20 ms.

Resolution Filters—100 Hz to 1 MHz (6 dB bandwidth ±20%) in decade steps. Shape factor ≤7.5:1 (60 dB/6 dB).

Frequency Span/Div—0 Hz (ZERO SPAN pushbutton or keypad data entry); 200 Hz to 10 GHz (in a 1-2-5 sequence) via span/div knob; 200 Hz to 15 GHz (to two significant digits) via keypad or start/stop data entry, or marker start/stop; full band via MAX SPAN pushbutton (12 bands). Accuracy ±5% of selected span/div.

AMPLITUDE RELATED

See 490 Series Family Specifications on page 179 for additional Amplitude Related details.

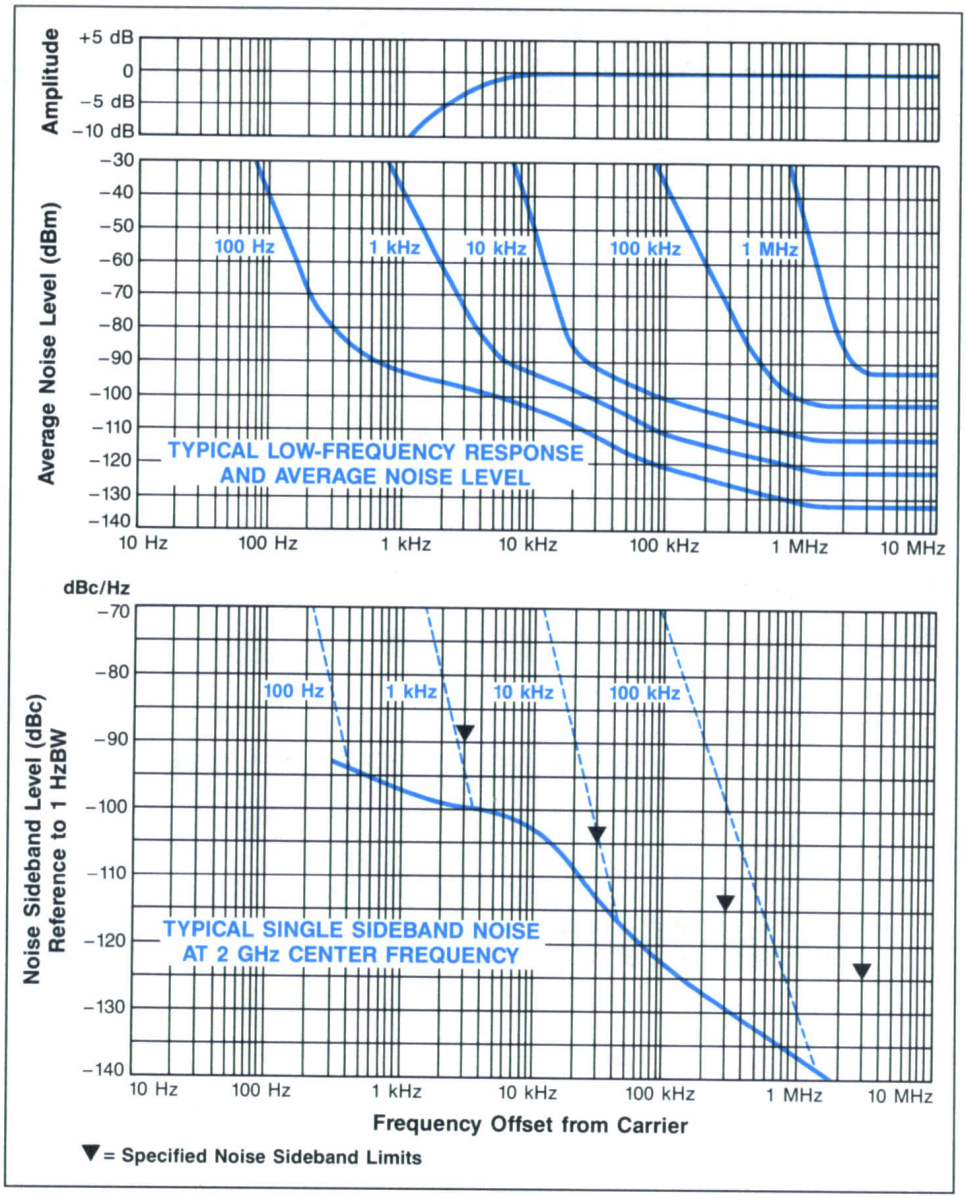
Display Dynamic Range—80 dB Log mode; 8 divisions Linear mode.

Noise Sidebands—At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency.

Noise Sidebands

dBc/Hz	Offset from Carrier
≤ − 95	3 kHz
≤ − 105	30 kHz
≤ − 115	300 kHz

*1 *Over the operating temperature extremes of −15 to +55°C, 1.5×10⁻⁵.*



SPURIOUS RESPONSES

Residual—≤ −100 dBm.

Harmonic Distortion—≤ −60 dBc for a −40 dBm input 50 kHz to 21 GHz in MIN Distortion mode. Not discernible above the noise (typically −100 dBc) for preselected bands (Option 01 only).

LO Emissions—≤ −10 dBm. Option 01: ≤ −70 dBm.

Third Order Intermodulation Distortion—≤ −70 dBc for CW signal (MIN Distortion Mode) Any two on-screen signals within any frequency span (50 kHz to 21 GHz); ≤ −100 dBc for signals spaced ≥100 MHz for preselected bands (Option 01 only).

INPUT SIGNAL

RF Input—Type "N" female 50 Ω nominal impedance.

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
50 kHz to 2.5 GHz	1.3:1 Max; 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max; 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max; 1.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max; 2.7:1 Typical	3.0:1

Measured at ±3 MHz of preselector peak for Option 01.

SENSITIVITY AND FREQUENCY RESPONSE

Band and Frequency Range	Harmonic Number	Sensitivity (dBm) at Minimum Resolution	Frequency Response (dB)*3
1 (50 kHz-4.2 GHz)*1	1	−125	±1.5
2 (1.7-5.5 GHz)*1	1	−125	±1.5
3 (3.0-7.1 GHz)*1	1	−125	±1.5
4 (5.4-12 GHz)*1	3	−110	±2.5
5 (15-21 GHz)*1	3	−105	±3.5
6 (18-27 GHz)	6	−108	±2.0
7 (26-40 GHz)	10	−103	±2.0
8 (33-60 GHz)	10	−103	±2.0
9 (50-90 GHz)*2	15	−105 at 50 GHz; −95 at 90 GHz	±3.0
10 (75-140 GHz)*2	23	−100 at 75 GHz; −85 at 140 GHz	±3.0
11 (110-220 GHz)*2	37	−90 at 100 GHz; −75 at 220 GHz	±3.0
12 (170-325 GHz)*2	56	−70 at 170 GHz; −55 at 325 GHz	±3.0

*1 *Band 1 is limited to 50 kHz to 1.8 GHz for preselected (Option 01) units. The preselector degrades minimum sensitivity by 5 dB (6 dB in BAND 3) and degrades frequency response by ±1.0 dB to 18 GHz; ±1.5 dB to 21 GHz.*

*2 *Frequency response for any 5-GHz band. Response is within ±6 dB referenced to 100 MHz.*

*3 *Measured with 10 dB RF Attenuation and peaking optimized (when applicable). Frequency response is within ±3.5 dB from 50 kHz to 18 GHz referenced to 100 MHz (±4.5 dB for Option 01).*

Maximum Safe Input—+30 dBm CW with ≥20 dB attenuation; +13 dBm CW with 0 dB attenuation; 0 V dc. Option 01 preselector: +30 dBm (1 W) CW; 75 W peak, 1 μs Pulse width, 0.001 duty; 0 dB attenuation. Do not apply dc.
1 dB Gain Compression—≥ −18 dBm in MIN Distortion Mode.

OUTPUT SIGNAL

Calibrator (Cal Out)—−20 dBm ±0.3 dB at 100 MHz ±1.0 kHz
1st and 2nd LO—Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +20 dBm; 2nd LO −22 dBm minimum to maximum of 0 dBm). These ports must be terminated in 50 Ω at all times.

CHARACTERISTICS

50/75 Ω OPTION 07
75 Ω INPUT RELATED

Provides 75 Ω input and dBmV calibration in addition to the normal 50 Ω input and dBm calibration. The 100 kHz resolution filter is replaced by 300 kHz to optimize the instrument for broadcast and CATV uses.
Center Frequency Range—1 to 1000 MHz.
Frequency Response—±2.0 dB from 5 to 1000 MHz; Typical response for the 1 to 5 MHz frequency range is <3 dB down from the 5 MHz response.
Reference Level Range—−68 to +79 dBmV (+89 dBmV is achievable in MIN NOISE mode and +99 dBmV in Reduced Gain mode).

Input Impedance—75 Ω; VSWR 1.35:1 (17 dB RL) maximum, 5 to 800 MHz; VSWR 1.6:1 (13 dB RL) maximum, 800 to 1000 MHz; BNC female.
Maximum Input Level—With 0 dB Attenuation: +78 dBmV, 100 V maximum (dc + ac peak).
Calibrator (Cal Out)—+20 dBmV ±0.5 dB; 75 Ω impedance nominal.

Sensitivity (Equivalent Input Noise)—5 to 1000 MHz—75 Ω Input

Sensitivity (dBmV)	Resolution Bandwidth
−74	100 Hz
−66	1 kHz
−56	10 kHz
−41	300 kHz
−36	1 MHz
50 Ω RF Input	
−90 (dBm)	300 kHz

ORDERING INFORMATION

492A Spectrum Analyzer **$29,040**
Includes: 50 Ω coax cable, N-to-N connector, 6 ft (012-0114-00); 50 Ω coax cable, BNC-to-BNC connector, 18 in. (012-0076-00); service manual Vol. 1 (070-5565-00); service manual Vol. 2 (070-5566-00); operator's manual (070-5562-00); N male-to-BNC female adaptor (103-0045-00); 2 Fast-Blo 4A fuses (159-0017-00); power cord (161-0104-00); power cord clamp (343-0170-00); CRT light filters (amber 378-0115-01, gray 378-0115-02); CRT mesh filter (378-0887-01).
492AP Programmable Spectrum Analyzer **$30,500**
Includes: Same as 492A plus programmer's manual (070-5564-00).

OPTIONS

Option 01—Adds preselection. **+$3,995**
Option 07—75 Ω input. **+$750**
Includes: BNC male-to-female adaptor connector (013-0126-00); 42 inch, BNC-to-BNC connector, 75 Ω coax cable (012-0074-00).
Option 21—18 to 40 GHz High Performance Waveguide Mixer Set. **+$2,650**
Includes: Diplexer assembly (015-0385-00); TNC-to-SMA adaptor (015-0388-00); SMA-to-SMA cable (012-0649-00).
Option 22—18 to 60 GHz High Performance Waveguide Mixer Set. **+$4,460**
Includes: Same as Option 21.
Option 39—Replaces Lithium with Silver batteries. **+$50**
Option 41—Digital Radio Enhancement. **+$450**
Option 42—110 MHz, >5 MHz bandwidth, IF Output. **+$750**
Option 45—MATE/CIIL language interface (492AP only). **+$4,975**
Option 52*1—North American 220 V configuration with standard power cord.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

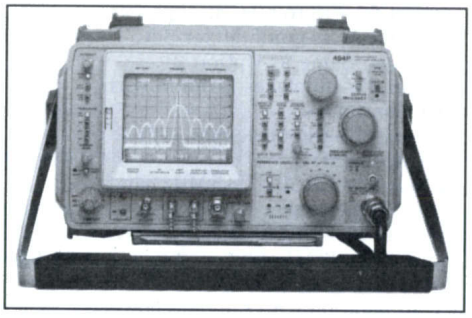
WARRANTY PLUS SERVICE PLANS

See Service section.
Option M1—2 Calibrations.
(492A) **+$1,995**
(492AP) **+$2,025**
Option M2—2 Years Service.
(492A) **+$3,380**
(492AP) **+$3,510**
Option M3—2 Years Service and 4 Calibrations.
(492A) **+$3,995**
(492AP) **+$4,045**

OPTIONAL ACCESSORIES

Operators Handbook—(492/492P) Order 070-5563-00. **$10**
Microwave Comb Generator—TM 500 Series compatible. Order 067-0885-00. **$1,815**
TR 503 Tracking Generator—For more information see page 201. **$7,080**
1405 TV Sideband Adaptor—525/60 Markers. See page 201. **$5,780**
Portable to Rack Adaptor—Order 016-0844-00. **$630**
GPIB Cable—Order 012-0630-01. **$95**
External Waveguide Mixers—492A/492AP
(18 to 26.5 GHz) Order WM 490K. **$1,310**
(26.5 to 40 GHz) Order WM 490A **$1,310**
(33 to 50 GHz) Order WM 490Q. **$1,520**
(40 to 60 GHz) Order WM 490U. **$1,805**
(50 to 75 GHz) Order WM 490V. **$2,045**
(60 to 90 GHz) Order WM 490E. **$2,225**
(75 to 110 GHz) Order WM 490W. **$2,280**
(90 to 140 GHz) Order WM 490F. **$2,445**
(110 to 170 GHz) Order WM 490D. **$3,410**
(140 to 220 GHz) Order WM 490G. **$3,490**
Tapered Transition—(Used with WM 490G) 220 to 325 GHz. Order 119-1728-00. **$1,200**

*1 *To order, contact your local Tektronix Sales Office.*



494/494P

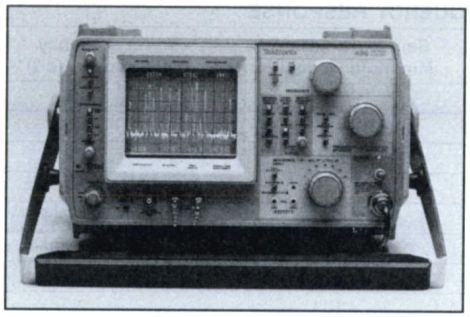
GPIB IEEE-488 — The 494P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Built-In Frequency Counter to 325 GHz**
- **HELP Manual in ROM**
- **Nonvolatile Memory Storage**
- **Keypad Data Entry**
- **Direct Plot Capability**
- **Full Three-Year Warranty**

The 494P offers the widest amplitude calibrated frequency range of any spectrum analyzer available: 10 kHz to 21 GHz in coax, and 325 GHz using one or more of ten Tek waveguide mixers. You get 30 Hz resolution bandwidth to 60 GHz, 100 Hz resolution bandwidth to 220 GHz, and 1 kHz bandwidth to 325 GHz with excellent sensitivity and low phase noise. Features common to the 490 Series are standard on the 494P, including digital storage, manual to programmable convertibility, and environmentalization per MIL-T-28800C, Type III, Class 3, Style C.

Nonvolatile memory retains up to ten setups and nine displays for rapid measurements and easy data comparison. One memory location stores on-screen settings in case power is turned off.

The fully programmable 494P provides easy-to-implement automated measurements. The 494P is straightforward to interface to our GPIB controllers. . .or yours. If you want to free your controller but still get graphics output, a convenient front panel PLOT button will send display data to a plotter.



496/496P

GPIB IEEE-488 — The 496P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **50 Ω/75 Ω Selectable Inputs**
- **1 kHz to 1800 MHz Coverage**
- **Amplitude Comparison in 0.25 dB Steps**
- **1 kHz Frequency Resolution in ΔF Mode**
- **Fully Calibrated Amplitude in dBm or dBmV**
- **80 dB Dynamic Range**

The 496 provides high performance spectrum analysis and measurements in the 1 kHz to 1.8 GHz range. Its high stability and 80 dB dynamic range meet your demands for proof-of-performance measurements, on site or on the bench.

Resolution bandwidth can be varied from 1 MHz to 30 Hz over the entire frequency range. Automatic phase lock stabilization reduces incidental FM to 10 Hz p-p; phase noise sidebands are at least −75 dBc at 30 times the resolution bandwidth offset. Frequency drift with phase lock is typically 1 kHz in ten minutes after 30-minute warm-up. And the 496 provides 1 kHz frequency resolution in ΔF mode.

Easy to Use—Anywhere

Simple 1, 2, 3 knob adjustment, set center frequency, frequency span and reference level. Power on sequence automatically normalizes operational settings and provides maximum input protection. Digital storage eliminates time-consuming display adjustments. Save A, B Minus Save A, Max Hold and Average modes let you compare, subtract, save maximum values or noise average (smooth) your displays.

ORDERING INFORMATION

494 Spectrum Analyzer. **$50,000**
Includes: Diplexer assembly (015-0385-00); 6-ft N-to-N connector 50 Ω coax cable (012-0114-00); N male-to-BNC female adaptor (103-0045-00); 18 in. BNC-to-BNC connector, 50 Ω coax cable (012-0076-00); two 4-A fast blow fuses (159-0017-00); 115-V power cord (161-0104-00); cord clamp (343-0170-00); CRT visor (016-0653-00); CRT light filters (amber 378-0115-01, gray 378-0115-02, blue 378-0115-00); operator's manual (070-4418-00); operator's handbook (070-4419-00); service manual, Vol. 1 (070-4416-00); service manual, Vol. 2 (070-4417-01).

494P Programmable Spectrum Analyzer. **$52,000**
Includes: Same as above, plus 2 meter, double shielded GPIB cable (012-0630-03); programmer's manual (070-4415-00).

496 Spectrum Analyzer **$32,950**
Includes: 18 in. BNC-to-BNC connectors 50-Ω coax cable (012-0076-00); 6 ft N-to-N connectors 50 Ω coax cable (012-0114-00); 115 V power cord (161-0118-00); N male-to-BNC female adaptor (103-0045-00); two 4-A fast blow fuses (159-0017-00); 2-A fast blow fuse (159-0021-00); cord clamp (343-0170-00); CRT visor (016-0653-00); CRT light filters (blue 378-0115-00, amber 378-0115-01, gray 378-0115-02); CRT mesh filter (378-00726-01); operator manual (070-3480-00); operator handbook (070-3483-00); service manual Vol. 1 (070-3481-00); service manual Vol. 2 (070-3482-00).

496P Fully Programmable Spectrum Analyzer **$32,950**
Includes: Same as 496 plus 2 meter double shield GPIB cable (012-0630-03); programmer's manual (070-3484-00).

OPTIONS (496/496P)

Option 07—75 Ω input. **+$750**
Includes: BNC male-to-female adaptor connector (013-0126-00); 42 inch, BNC-to-BNC connector, 75 Ω coax cable (012-0074-00).
Option 42—110 MHz, >5 MHz bandwidth, IF Output. **+$1,500**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY PLUS SERVICE PLANS (494P Only)

See Service section.
Option M1—2 Calibrations. **+$715**
Option M2—2 Years Service. **+$1,350**
Option M3—2 Years Service and 4 Calibrations. **+$2,785**
Option M4—5 Calibrations. **+$1,630**
M5—2 Years Service and 9 Calibrations. **+$4,240**

WM 490 Series

Waveguide Mixers

Tektronix Waveguide Mixers cover from 18 to 325 GHz with optimum flatness.

They are designed specifically for use with the Tektronix 490 and 2750 Series Spectrum Analyzers, but are compatible with most spectrum analyzers.

Two microwave mixers, with field replaceable diodes, cover ranges 18 to 26.5 GHz and 26.5 to 40 GHz. When used with the 490 and 2750 Series, the frequency response is ±2 dB.

Eight millimeter-wave mixers cover the 33 to 220 GHz range in the standard Mil-spec band ranges. J to G band flange transition (119-1728-00) converts the WM 490G mixer to cover the 220 to 325 GHz range.

All mixers are gold-plated brass, conforming to MIL-G-45204 Class I, Type 1 specifications and will withstand harsh environments. Mixer sets come complete with a container for spare diodes, a 28-inch cable, an instruction manual, and a wood storage box with foam cutout storage locations for five mixers.

A Diplexer Assembly is also available. It includes TNC-to-SMA adaptor, cable, and SMA semirigid coax. A diplexer is required for waveguide mixers when used on 490 and 2750 Series spectrum analyzers.

INDIVIDUAL MIXER ELECTRICAL CHARACTERISTICS

Freq. Range (GHz)	Tektronix Model No.	Band Desig.	Sensitivity (dBm)*1	Freq. Resp.*2 (dB)	Conv. Loss*3 Typ. (dB)	Low-Pass Cut-Off Freq.*7
18 to 26.5	WM 490K	K	−100	±2	−30	12 GHz
26.5 to 40	WM 490A	A	−95	±2	−30	16 GHz
33 to 50	WM 490Q	Q	−95	±2	−30	21 GHz
40 to 60	WM 490U	U	−95	±2.5	−30	16 GHz
50 to 75	WM 490V	V	−95 at 50 GHz −90 at 75 GHz typ.	±3 typ.*4	−30 at 50 GHz −35 at 75 GHz	28 GHz
60 to 90	WM 490E	E	−95 at 60 GHz −85 at 90 GHz typ.	±3 typ.*4	−30 at 60 GHz −40 at 90 GHz	28 GHz
75 to 110	WM 490W	W	−90 at 75 GHz −80 at 110 GHz typ.	±3 typ.*4	−35 at 75 GHz −45 at 110 GHz	30 GHz
90 to 140	WM 490F	F	−85 at 90 GHz −75 at 140 GHz typ.	±3 typ.*4	−40 at 90 GHz −50 at 140 GHz	32 GHz
110 to 170	WM 490D	D	−80 at 110 GHz −70 at 170 GHz typ.	±3 typ.*4	−45 at 110 GHz −55 at 170 GHz	40 GHz
140 to 220	WM 490G	G	−75 at 140 GHz −65 at 220 GHz typ.	±3 typ.*4	−50 at 140 GHz −60 at 220 GHz	40 GHz
220 to 325	WM 490G*6 Opt. 01	J	−65 at 220 GHz −50 at 325 GHz typ.*5	±3 typ.*4	−60 at 220 GHz −70 at 325 GHz	—

*1 *Equivalent average noise level using a 490 or 2750 Series spectrum analyzer in 1 kHz resolution bandwidth.*

*2 *Maximum amplitude variation across each waveguide mixer band (using a 490 or 2750 Series spectrum analyzer with peaking control optimized at each frequency in response to a −30 dBm CW input signal to the mixer).*

*3 *LO drive +10 dBm peaking control optimized.*

*4 *Over any 5 GHz bandwidth for millimeter wave mixers above 60 GHz.*

*5 *Value estimated at 325 GHz.*

*6 *Tapered waveguide transition allowing WM 490G to cover this range.*

*7 *These low-pass filters are in LO/IF connector.*

INDIVIDUAL MIXER MECHANICAL CHARACTERISTICS

Tektronix Model*3	Waveguide (EIA)	Flange (JAN)	Length cm	Length in.	Width*1 cm	Width*1 in.	Height*1 cm	Height*1 in.
WM 490K	WR-42	UG-595/U	8.97	3.53	2.22	0.875	3.68	1.45
WM 490A	WR-28	UG-599/U	6.93	2.73	1.90	0.750	3.35	1.32
WM 490Q	WR-22	UG-383/U	5.37	2.125	1.84	0.725	2.82	1.110
WM 490U	WR-19	UG-383/U-M	4.52	1.78	1.84	0.725	2.45	0.980
WM 490V	WR-15	UG-385/U	4.31	1.70	0.89	0.350	2.29	0.900
WM 490E	WR-12	UG-387/U	4.31	1.70	0.89	0.350	2.29	0.900
WM 490W	WR-10	UG-387/U-M	4.31	1.70	0.89	0.350	2.29	0.900
WM 490F	WR-08	UG-387/U-M*2	4.31	1.70	0.89	0.350	2.29	0.900
WM 490D	WR-06	UG-387/U-M*2	4.31	1.70	0.89	0.350	2.29	0.900
WM 490G	WR-05	UG-387/U-M*2	4.31	1.70	0.89	0.350	2.29	0.900
119-1728-00 G-J Band flange transition	WR-05 WR-03	74-003 74-005						

*1 *Physical dimensions exclude contribution due to the diameter of round waveguide flanges in U, V, E, W, F, D, and G bands.*

*2 *All mixers are equipped with standard UG-XXX/U type flanges as indicated. Flange adaptors to standard MIL-F-3022 type flanges are provided in F, D, and G bands at no additional charge.*

*3 *All mixers include a protective flange cover, an LO/IF port protective shorting cap, and two captive flange screws for round flange mixers.*

CHARACTERISTICS

For All Waveguide Mixers—Maximum CW RF Input Level: +20 dBm (100 mW).

Maximum PULSED RF Input Level—1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width.

LO Requirement—+7 dBm minimum, +15 dBm maximum, +10 dBm typical.

Bias Requirement—−2.0 to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0 mV to 20 mA of bias current.

1 dB Compression Point—+13 dBm typical (at system level). −10 dBm typical when used with the 490 and 2750 Series spectrum analyzers.

ORDERING INFORMATION

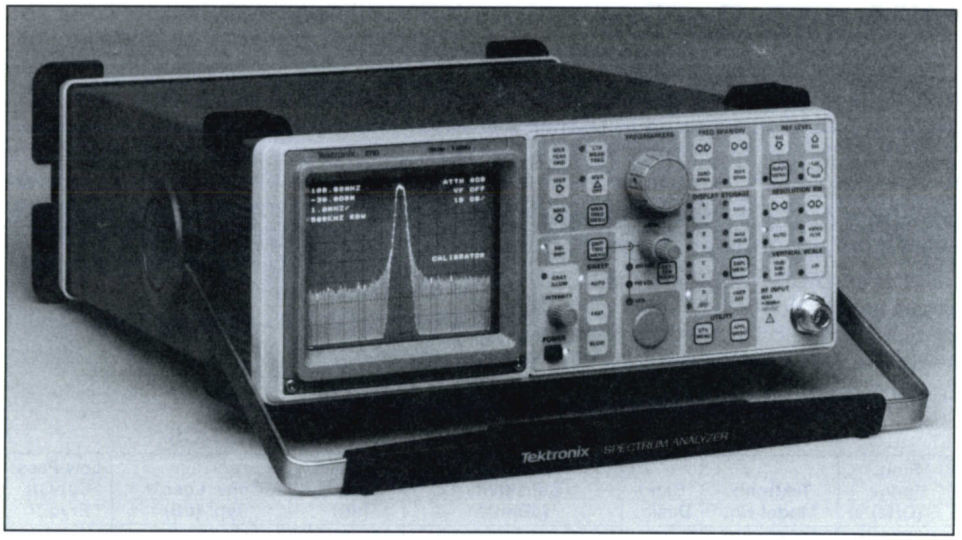
18 to 26.5 GHz—Order WM 490K. **$1,310**
26.5 to 40 GHz—Order WM 490A. **$1,310**
33 to 50 GHz—Order WM 490Q. **$1,520**
40 to 60 GHz—Order WM 490U. **$1,805**
50 to 75 GHz—Order WM 490V. **$2,045**
60 to 90 GHz—Order WM 490E. **$2,225**
75 to 110 GHz—Order WM 490W. **$2,280**
90 to 140 GHz—Order WM 490F. **$2,445**
110 to 170 GHz—Order WM 490D. **$3,410**
140 to 220 GHz—Order WM 490G. **$3,490**
220 to 325 GHz—Order WM 490G Opt. 1. **$1,260**
18 to 40 GHz Set—Order WM 4902. **$2,675**
Includes: WM 490K, WM 490A.
18 to 60 GHz Set—Order WM 4903. **$4,515**
Includes: WM 490K, WM 490A, WM 490U.
18 to 90 GHz Set—Order WM 4904. **$6,740**
Includes: WM 490K, WM 490A, WM 490U, WM 490E.
18 to 140 GHz Set—Order WM 4905. **$9,190**
Includes: WM 490K, WM 490A, WM 490U, WM 490E, WM 490F.
Cable—Order 012-0649-00. **$33**
Case—Order 016-0465-01. **$30**
140 to 220 GHz—Tapered transition 119-1729-00 used with WM 490F. **$2,445**
Diplexer Assembly—Order 015-0385-00 **$210**

GENERAL PURPOSE WAVEGUIDE MIXERS AND SET

12.5 to 18 GHz—Order 119-0097-01. **$270**
18 to 26.5 GHz—Order 119-0098-01. **$305**
26.5 to 40 GHz—Order 119-0099-01. **$500**
Cable—Order 012-0748-00. **$60**
Case—Order 016-0465-01. **$30**
12.5 to 40 GHz Set—Order 016-0640-00. **$1,325**
Includes: 119-0097-01, 119-0098-01, 119-0099-01.

2710

- **More Performance, Lower Price**
- **Center Frequency Accuracy of 1×10^{-5} ±5 kHz**
- **Optional, Internal Frequency Counter**
- **Four-Trace Digital Storage and True Analog Display**
- **Faster Measurements With Full Marker/Delta Marker Capabilities**
- **Aural and Optional Video Demod**



The Tektronix 2710 Spectrum Analyzer is a real value breakthrough. The portable 2710 weighs less than 20 pounds and provides 10 kHz to 1.8 GHz coverage with center frequency accuracy of 10^{-5} ±5 kHz. Resolution bandwidth ranges from 3 kHz to 5 MHz to examine wideband signals with minimum measurement distortion. The 2710's outstanding frequency accuracy is available at wide spans and with readout resolution to the nearest hertz with an optional built-in frequency counter.

The 2710 includes 80 dB display dynamic range and 1, 5, and 10 dB/div vertical scale log modes. Sensitivity is −117 dBm at 3 kHz RBW. A built-in preamp improves sensitivity to −129 dBm (at 3 kHz RBW); it boosts low level signals for accurate measurement without degradation due to front-end losses of measurement equipment.

The 2710 marker/delta marker capability includes front panel controls for peak find, next right peak, next left peak, and marker to center. Using the FREQ/MKR menu, several other marker maneuvers may be made including next highest and next lowest peak. The 2710 also includes a true analog display capability. . .very important in seeing video modulation phenomena or IMD beats.

AM/FM detectors with audio amplifier, speaker, and headphone jack permit evaluation of demodulated audio. A new, optional video monitor mode presents the demodulated, rasterized video on the CRT of the spectrum analyzer—excellent for signal or interference identification. The 2710 also enables direct depth of modulation and FM deviation measurements and viewing of waveforms triggered off *any* video horizontal line. . . great for looking at VITS!

Additional features include automatic calibration, selectable reference level units (dBm, dBmV, dBμV, dBV, dBμW), selectable 50 Ω/dBm or 75 Ω/dBmV operation, signal track, bandwidth characterization mode, and carrier to noise mode.

The 2710 capabilities are accessed via easy-to-read and logically grouped controls on the front panel. Secondary functions are implemented from easy to understand menus.

In basic spectrum analyzer mode, measurements are as easy as 1, 2, 3. . . frequency, reference level, and span/div controls help you focus on a signal. . . microprocessor power takes care of keeping the 2710 in calibration. Frequency, span/div, and other control parameters can be directly entered through a front panel keyboard.

CHARACTERISTICS

The following specifications and features apply after a 15-minute warmup period unless otherwise noted.

FREQUENCY RELATED

Frequency Range—10 kHz to 1.8 GHz.
Center Frequency Accuracy—1×10^{-5}±5 kHz.
Frequency Counter Accuracy (Opt. 02)—1×10^{-5} ±10 Hz, 0-50°C; 3(10^{-6}) ±10 Hz/year.
Dot Marker Frequency Accuracy—CF plus span/div linearity.
CF Readout Resolution—≤ 1% span/div, 1 MHz max.
Frequency Counter Readout Resolution (Opt. 02)—1 kHz or 1 Hz, selectable.
Short-term Drift—20 kHz maximum drift between correction cycles. Typical short-term drift between correction cycles is within 5 kHz.
Residual FM— 2 kHz p-p/20 msec at span/div ≤ 50 kHz (unphaselocked).
Resolution Bandwidth— (−6 dB) 5 MHz, 500 kHz, 30 kHz, 3 kHz.
Resolution Bandwidth Shape Factor—≤ 6:1.
Noise Sidebands—> −70 dBc at 30×RBW (Resolution Bandwidth).
Video Filter—Approx. 1/100 (Auto) of RBW. Manual selection available.
Freq. Span/Div Range—180 MHz to 10 kHz. Selected in 1,2,5 sequence or 2 significant digits via menu. Max span, zero span keys.
Span Accuracy—±3% measured over the center eight divisions.

AMPLITUDE RELATED

Flatness—±1.5 dB measured with 10 dB RF attenuation (preamp off).
Vertical Display Modes—10, 5, 1 dB/div, Linear.
Measurement Range— −129 to +20 dBm (preamp on).
Display Dynamic Range—80 dB max.
Reference Level Range—LOG Mode: −70 to +20 dBm (−20 to +70 dBmV). LINEAR Mode:8.8 μV/div to 280 mV/div.
Reference Level Steps—LOG Mode:1 dB/10 dB. LINEAR Mode: 1,2,5 sequence: 10 μV/div to 280 mV/div.
Mixer Input Level—Automatically controlled by instrument for on-screen signals. Level selectable between −20 to −50 dBm.
Display Amplitude Accuracy—10 dB/div: ±1.0 dB/10 dB to max. cum. error of ±2 dB over 80 dB range. 5 dB/div: ±1.0 dB/10 dB to max. cum. error of ±2.0 dB over 40 dB range. 1 dB/div: 1 dB max. error over 8 dB range. Linear: ±5% of full scale.
RF Attenuation Range—0-50 dB, 2 dB steps.
Sensitivity— −117 dBm at 3 kHz RBW. −129 dBm at 3 kHz RBW w/preamp.

SPURIOUS RESPONSE (with preamp off)

Residual Spurious Response—≤ −100 dBm referenced to input of 1st mixer.
3rd Order IM Distortion—≤70 dBc, from any two on-screen signals within any frequency span at −20 dBm input level, 10 dB atten.
2nd Harmonic Distortion—≥ 66 dBc with +30 dBm input and 0 dB attenuation.
LO Emission—−70 dBm with 0 dB RF attenuation.
RF Input—Type N connector, 50Ω.
VSWR with 10 dB or more RF attenuation—1.5:1 max.
Maximum Safe Input—±20 dBm (0.1 W) continuous peak with 0 RF attenuation; 100 VDC.
1 dB Compression Point at IF—≥ −15 dBm with 0 dB RF attenuation.

SWEEP RELATED

Sweep Times—1 μsec to 2 sec/div in 1,2,5 seq. (7 decade range); AUTO SWEEP mode; MANUAL SWEEP select.
Sweep Time Accuracy—±10% over the center 8 divisions.
Trigger—Free run, internal, external, line, TV field, TV line, single sweep, manual scan.
Trigger Amplitude—Internal: One division or more of signal. External: 1.0 V peak, minimum; DC coupled (15 Hz to 1 MHz).

OTHER INPUTS/OUTPUTS

External Trigger—BNC connector, 10 kΩ impedance, DC coupled 0.1 μs minimum pulse width.
External Video Input—DC coupled, 0-100 kHz, 0-1.6 V (200 mV/div) signal input for vertical deflection of CRT beam.
Sweep Gate Out—TTL level signal that increments while CRT beam sweeps.
Chassis and Signal Ground.
Sweep Output—+1.3 to −1.3 V ramp, negative going ramp, proportional to the horizontal sweep. Source impedance ≤50 Ω, load impedance ≥10 kΩ.
Video Output—0 to +1.6 V of video signal, proportional to vertical display amplitude. 0 V is top of screen. 1 kΩ impedance.
Temperature—Operating: 0 to +50° C (MIL-T-28800C). Nonoperating: −55 to +75° C.
Humidity (Non-operating)—Five cycles (120 hours) per MIL-T-28800C, class 5.
Vibration—Meets MIL-T-28800C Method 514 Procedure X (modified).
Shock (Operating and Non-operating)—Three guillotine-type shocks of 30 g, one-half sine, 11 ms duration each direction along each major axis; total of 18 shocks.
Radiated and Conducted Emissions—Meets FCC Part 15, sub-part J, class B and VDE 0871, class B.
Radiated and Conducted Susceptibility—Meets Part 7 Mil Std 461B.

GENERAL CHARACTERISTICS

Power Requirements—110 W MAX (1.3 A) at 115 V, 60 Hz. Operates 48 to 440 Hz, 90 to 250 V ac. Battery power option available.
Weight—<20 lb (9.1 kg) nominal for basic configuration.
Dimensions (H, W, D) with feet, handle and front panel cover—5.4×14.2×17.5 inches (137×361×445 mm).

OTHER CAPABILITIES

Markers—Single marker/delta markers; next right, next left peaks; next lower, next higher peaks; (highest) peak find; marker to CF; markers to start/stop frequencies; transpose Δ markers.
Nonvolatile memory—(Opt. 11, No charge): A, B, C displays SAVED at power down, 8 front panel setups, instrument control status. Lithium battery backup.
Digital Storage Display—Selectable acquisition modes of positive peak only, positive/negative peak. SAVE A, B, C and active D trace; up to four traces on screen; MAX HOLD A, B; B, C minus A; WATERFALL display mode; ensemble averaging; (min, max, mean, min/max); digital storage off (analog sweep).
Ensemble Averaging—Provides weighted averaging of display resulting in reduction of random noise and impulse signals.
Direct Entry of Control Parameters—Frequency, span/div, reference level, RBW, video filter, vert. scale, sweep rate.
Noise Measurement, Carrier-to-Noise Measurement—Auto Normalization and correction, user-definable system BW.
Bandwidth Measurement—User definable "dB down" points, automatically updated.
Internal Freq. Counter (signal counter), selectable 1 kHz/1 Hz readout resolution—Option 02.
Internal Preamplifier—Preamp may be switched in/out of circuit (degrades flatness above 500 MHz, provides approx. 12 dB sensitivity improvement).
Alternate Reference Level Units—dBm, dBmV, dBV, dBμV, dBμW.
User-definable Power-on Status—Instrument powers up to user-definable state or supplied default settings.
Direct Plot—With Centronics.
Constant Rate Tuning—Same on-screen tuning sensitivity regardless of span/div selection.
Center Measure—Signal nearest CF (from any screen location) is centered with frequency and peak amplitude automatically read out (not a marker mode). The centered signal will be counted if the Option 02 Frequency Counter is installed.
Signal Track—Drifting signal is kept at display center with correct frequency and peak amplitude displayed.
Graticule Illumination—Green, contrast enhancement for CRT photography.
Centronics Interface—Supports Epson FX Series Printers and Tek HC100 Printer/Plotter.
AM/FM Detectors—Built-in amplifier, speaker and headphone jack.
Video Monitor Mode (Opt. 10)—Allows direct viewing of television picture on analyzer screen. Functions in NTSC, PAL and SECAM systems. Includes selectable horizontal line trigger.

ORDERING INFORMATION

2710 Spectrum Analyzer **$8,250**
Includes: Power cord (U.S. 115 V/60 Hz) (161-0104-00); operator's manual (070-6022-00); front cover (300-2520-00).

OPTIONS

Option 01—300 Hz resolution bandwidth/phaselock stabilization/5×10^{-7} frequency accuracy. **+$1,100**
Option 02—Internal frequency counter with selectable 1 kHz/1 Hz readout resolution. **+$600**
Option 06—Battery operation. **+$1,710**
Option 09—Centronics interface. **+$300**
Option 10—Video monitor mode. **+$450**
Option 11—Nonvolatile storage. **NC**
Option 15—Tek 1405 TV Sideband Analyzer Interface. **+$200**
Option 30—Rackmount for 19-inch rack width, 5 in. height. **+$150**
Option 33—Travel Line Package Includes: Accessory pouch; carrying strap; smoke-gray CRT filter; vinyl rain cover. **+$95**
Option 34—Portable to Rackmount adaptor for 19-inch rack width, 7 inch height. **+$425**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

Option M1—2 Calibrations. **+$710**
Option M2—2 Years Service. **+$1,190**
Option M3—2 Years Service and 4 Calibrations. **+$1,430**

OPTIONAL ACCESSORIES

Front Panel Cover—Order 220-2520-00.*1
Accessory Pouch—Mounts on top. Order 016-0677-02. **$45**
Viewing Hoods—
(Collapsible) Order 016-0592-00. **$14.25**
(Binocular) Order 016-0566-00. **$19**
(Polarized) Order 016-0180-00. **$60**
Carrying Strap—Order 346-0199-00. **$17.50**
Shipping Case—Order 016-0792-01. **$360**
Smoke Gray CRT Filter—Order 337-2775-02. **$2.35**

*1 *Contact your local Tektronix Sales Office.*

Spectrum Analyzer Systems

- **Systems Include Tek's High Performance Spectrum Analyzers, a Compaq Personal Computer, and GRASP Software**
- **Powerful GRASP Software Aids in Acquiring, Processing, Storing, and Displaying Spectral Data**
- **Each System is Ordered as an Option to a Spectrum Analyzer**

Tektronix spectrum analyzer systems are configured around Compaq personal computers and Tektronix laboratory quality, programmable spectrum analyzers. Coupling the PC to the analyzer via the IEEE-488 bus enables the user to take advantage of the PC's capability, as well as the power and versatility of Tektronix spectrum analyzers. An IEEE-488 interface (National Instruments PC2A card) is included in each package.

A highly versatile General RF Applications Software Package (GRASP) offers routines for several types of Measurements, Filter Tests, Signal Searches, Waveform Operations, and Utilities. Each routine is selected through easy, menu-driven operation.

Tek's spectrum analyzer systems are ordered as standard options to the following analyzers: 495P, 492AP, 494AP, 2753P, 2754P, 2755P, and 2756P. Packages are not available in all countries. Contact your local Sales Engineer for availability.

Option 23 is intended for the user who already has a PC-compatible computer. Options 24 through 28 are turnkey systems designed for R&D, manufacturing test, and general RF automated testing. Option 29 adds a graphics-compatible printer to each of these systems.

Each of the computer options are configured and checked out prior to shipment. Thus, the customer receives a turnkey system and should encounter minimal effort in configuring and running the system.

Tektronix can also provide Technical Assistance Services for users requiring custom programming or applications assistance. Contact your Tektronix Sales Engineer for details.

ORDERING INFORMATION

Tek's spectrum analyzer packages are ordered as standard options to the following analyzers: 495P, 492AP, 494AP, 2753P, 2754P, 2755P, and 2756P.

When ordering, please use the model number and desired options of the spectrum analyzer plus one of the following package options.

Option 23—GRASP and GPIB Interface. **+$1,750**
Includes: GRASP software, National's PC2A (GPIB) card, and GPIB cable.

Option 24—Portable II, Model 2. **+$4,800**
Includes: GRASP, PC2A, GPIB cable, Compaq Portable II (Model 2), 80286 processor, 256K byte RAM, 2 each 360K-byte floppy drives, built-in monitor, and serial/parallel interface.

Option 25—Deskpro, Model 2. **+$4,900**
Includes: GRASP, PC2A, GPIB cable, Compaq Deskpro (Model 2), 8086 processor, 256K byte RAM, 2 each 360K-byte floppy drives, enhanced color display, and serial/parallel interface.

Option 26—Deskpro 286, Model 1. **+$6,400**
Includes: GRASP, PC2A, GPIB cable, Compaq Deskpro 286 (Model 1), 80286 processor, 256K byte RAM, 1.2M-byte/360K-byte floppy drives, enhanced color display, and serial/parallel interface.

Option 28—Deskpro 286, Model 20. **+$8,400**
Includes: GRASP, PC2A, GPIB cable, Compaq Deskpro 286 (Model 20), 80286 processor, 640K byte RAM, 20M-byte hard drive, 1.2M-byte/360K-byte floppy drives, enhanced color display, and serial/parallel interface.

Option 29—Epson printer. **+$550**
Includes: Epson FX-86E printer and parallel interface cable.

NOTE: Options 24 through 29 are available in the U.S. only. See your local Sales Engineer for more information.

TekSPANS®

MEASUREMENTS
Harmonic Distortion
Amplitude Modulation
Signal-to-Noise
Frequency Response
Cursors

FILTER TESTS
Band-pass Filter
Low-pass FIlter
High-pass Filter

SIGNAL SEARCH
Fast Search
Precise Search
Spur Search
Automatic Identify

WAVEFORM OPERATIONS
Acquire AVIEW Waveform
Acquire BVIEW Waveform
Send to Instrument
Store on Disk
Load from Disk
Graph Waveform
Overlay Waveform
Redraw Waveform
Normalize Waveform

UTILITIES
Talk/Listen (Command)
Sensitivity Test
Resolution Filter Test
Calibration Assistance
Select Instrument
Select Disk

The GRASP main menu lists all submenus and their routines.

GRASP® (General RF Applications Software Package)

- **Value Packed Software—Performs Automated Spectrum Analysis on Choice of Popular Controllers**
- **Applications Routines Are Selected Through Easy, Menu-driven Operation**
- **Supports IBM PC XT/AT and Compatible Computers (Option 01/1A)**
- **Supports HP Series 200 Controllers (Option 02/2A)**
- **Supports Tek 4041 Controller and Multiple-Site/Remote-Site Monitoring of RF Equipment (Option 03)**

Tek's GRASP (General RF Applications Software Package) is the first in a family of spectrum analyzer software packages called TekSPANS. GRASP is designed to capitalize on the power of Tek's programmable spectrum analyzers and a choice of controllers such as Tek's 4041, IBM PCs or compatibles, and HP 200 Series.

This highly versatile software package offers many applications/utility routines that are selected through easy, menu-driven operation. Even a nontechnical operator has immediate access to operations such as swept-frequency measurements, waveform storage and recall, and performing signal analysis, including measurements of harmonic distortion and signal-to-noise ratio.

From GRASP's main menu, a user selects among any of the submenus for Measurements, Filter Tests, Signal Search routines, Waveform Operations, and Utilities. Selections are made by pressing the appropriate function key shown on-screen. Prompts guide the user through each measurement task. For example, users can utilize a Cursors routine which displays the instrument CRT on their terminal screen. It calculates and displays both the absolute amplitude and frequency of one or two marked signals, plus the relative (delta) amplitude and frequency difference between the two markers.

A powerful feature of GRASP (Option 03) is the ability to monitor one or more remote sites via phone lines and modems. The user can exercise complete control over the spectrum analyzer at the remote site, and can graph the acquired waveform at the base-site terminal. The user can also specify a frequency and amplitude window, providing for an automatic telephone call back to the base site when the signal drops out of tolerance.

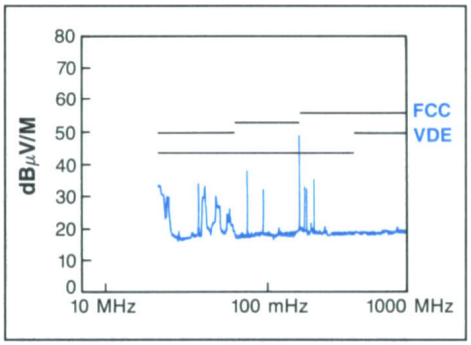
Complete source code is provided, thereby simplifying the task of integrating user-written routines into GRASP.

ORDERING INFORMATION

S26RF00 GRASP. **$875**
Includes: Software, license agreement, and users manual.

OPTIONS

Option 01—IBM PC AT high density disk. **NC**
Option 1A—IBM PC double density disk. **NC**
Option 02—HP 200 Series 5¼″ double density disk. **NC**
Option 2A—HP 200 Series 3½″ micro disk. **NC**
Option 03—Tek 4041 DC-100 Tape. **NC**



Sample graph from radiated emissions test.

EMI Software

- **Cost-Effective Approach to Automated EMI Testing**
- **Software Runs on IBM PC XT/AT, and Compatible Computers**
- **Prequalification Testing for FCC/VDE and MIL-STD-461B/462 CE03 and RE02. Tests Are Accessed Through Easy, Menu-Driven Operation**

Tek's EMI Prequalification Software provides a low-cost, time-saving approach to EMI conducted and radiated emissions testing. It is particularly useful to design engineers who require a compact system for measuring and documenting EMI levels during the various design stages.

When used with a Tek programmable spectrum analyzer and an IBM or compatible PC (equipped with a National Instruments PC2A IEEE-488 interface card), this software enables a cost-effective approach for integrated EMI testing. This highly versatile software package includes test routines for FCC Part 15J (A & B), VDE 0871 (A & B), and MIL-STD-461B/462 RE02 and CE03. Routines are accessed through easy, menu-driven operation. For each class of test, routines are provided for acquiring data, graphing results (semilog plot with selected limits superimposed) and creating printouts of frequencies approaching or exceeding limits. Capability is also included for updating and displaying antenna factors.

This package provides a user's manual, which includes a tutorial section on basic EMI measurements.

ORDERING INFORMATION

S26EM00 EMI Prequalification Software. **$1,475**
Includes: Software on DS/DD diskettes, license agreement, and user's manual.
Option 09—Source code. **+$1,000**

MONITOR
Enter Parameters
Take a Measurement
Report Errors
Hang-Up/Monitor
Immediate Call Back
Show Parameters

WAVEFORM OPERATIONS
Acquire AView Waveform
Acquire BView Waveform
Send to Instrument
Store on Disk
Load from Disk
Graph Waveform
Acquire Mode: Norm

UTILITIES
Talk/listen (Command)
Sensitivity Test
Resolution Filters Test
Calibration Assistance
Select Instrument
Select Disk
User Program

MEASUREMENTS
Harmonic Distortion
Amplitude Modulation
Signal-to-Noise

SIGNAL SEARCH
Fast Search
Precise Search
Spur Search

RSM provides a variety of routines for signal monitoring and interactive testing.

NEW RSM (Remote Site Monitoring Software) for the PC

- **Control Tektronix Instrumentation from Anywhere in the World**
- **Monitor RF Signals at One or More Remote Installations**
- **Immediate Call-back Warning of Failure Conditions**
- **Applications Routines Are Selected Through Pop-up Menu Structure.**

RSM (Remote Site Monitoring) software, part of the TekSPANS family of spectrum analysis software, simplifies the control and data analysis of instruments at remote sites or in hostile environments. RSM merges the power and precision of Tek's Spectrum Analyzers with the economy of PC-based controllers to provide cost effective, remote-site monitoring and control.

RSM provides the ability to connect, via telephone, a pair of PCs. The remote-site PC is connected to the remote Tek 490P or 2750P Series Spectrum Analyzer, and perhaps to other Tek programmable instruments, via the IEEE 488 interface. This remote PC includes either the Tek GURU interface or the National Instruments PC2 or PC2A card.

The host-site PC is located at a convenient location such as an office or lab. At the host site the user has complete control over the operations of the remote-site PC, and all screen displays seen are identical to those currently appearing at the remote site, including full color.

From RSM's main menu, a user selects any of the submenus for Monitor, Waveform Operations, Utilities, Measurements, and Signal Search. Each of these submenus and the included routines are accessed through a pop-up menu structure.

The Monitor menu contains several routines that control the operation of the Independent Automated Signal Monitoring mode. RSM continually checks the RF input signals to the remote spectrum analyzer and compares them to a user-defined frequency/amplitude tolerance window. The user can define all monitoring parameters, verify pass/fail conditions of the current setup, initiate monitoring, and report all current and logged errors.

The Monitor menu includes a Hang-Up/Monitor routine which terminates any existing phone connection between the host and remote sites and initiates the signal monitoring routine as specified. If the signal drops out of the previously defined amplitude/frequency window, an automatic telephone call is placed to the host site to warn the operator of the error condition. A Local Error Logging routine is also provided which logs all errors at the remote site for later analysis.

The Waveform Operations menu provides several routines such as acquiring and graphing one or more signals, storing and loading waveforms to disk, and sending waveforms back to the analyzer for display.

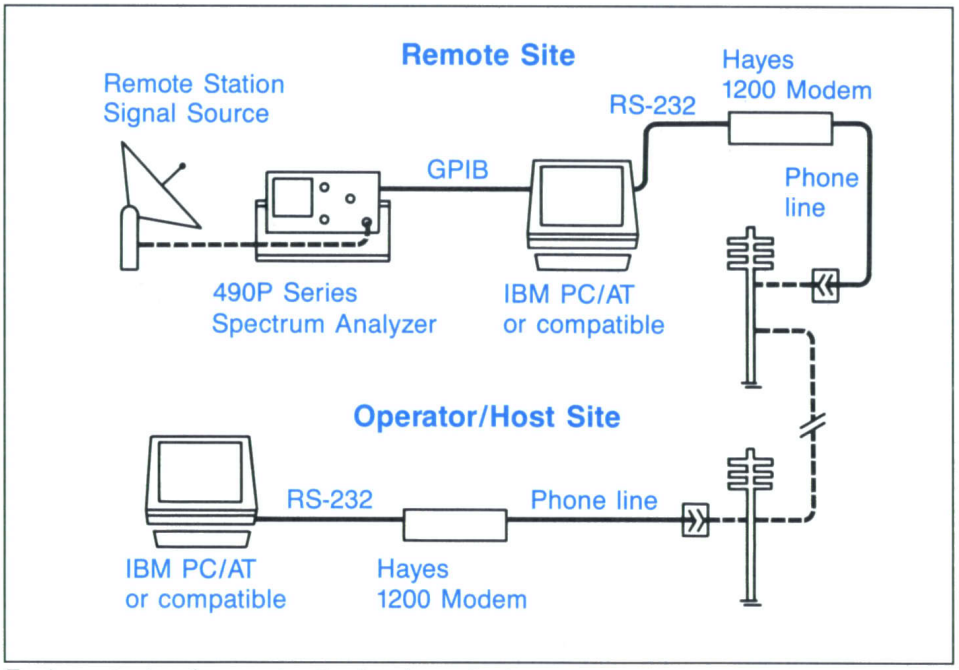
The Utilities menu includes a Talk/Listen routine that sends commands and queries to the spectrum analyzer or other Tek instruments at the remote site. This menu also allows inclusion of a user-written program to perform tasks such as automated signal surveillance of a set of communication channels.

The Measurements and Signal Search menus provide a variety of routines for performing tasks such as measuring harmonic distortion and amplitude modulation, as well as performing a precise signal search over a specified frequency range.

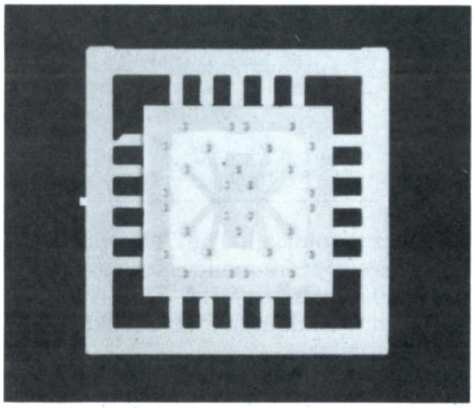
For maximum flexibility, the RSM system is offered in two packages: a host-site module and a remote-site module. At least one of each module is required to comprise a working remote monitoring system. Both modules are provided with source code.

ORDERING INFORMATION

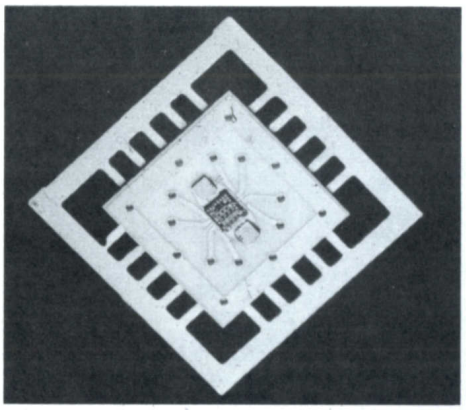
S26RM00 RSM Host-Site module. **$300**
S26RM01 RSM Remote-Site module. **$750**
Includes: Software on DS/DD diskettes, license agreement, and users manual.



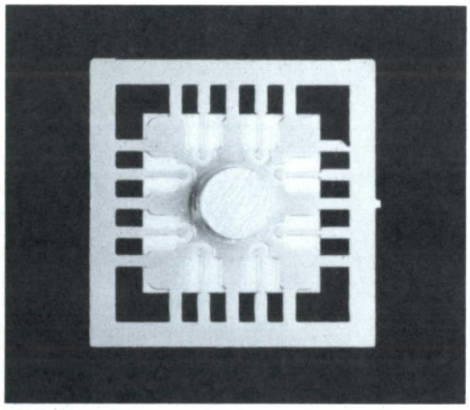
Equipment setup for remote site signal monitoring.



TPAK142 (top view).



Typical Application used in Micro-S product line, TriQuint Semiconductor, Inc.



TPAK142 (bottom view).

TEKPAC™ Hermetic MMIC Packages

- **Multiple RF Signal Lines From Motherboard to Chip**
- **10^{-8atm} Hermeticity**
- **Direct-Contact Heatsinking**

Hermetic, surface-mount MMIC packages are now available from Tektronix using a patented via design. An evaluation kit with packages, lids, and 8-port SMA text fixture, and calibration standards is also available.

TPAK142 CHARACTERISTICS

	0-12 GHz	12-18 GHz
VSWR[1]	1.2:1 max	2.0:1 max
Insertion loss[1]	0.5 dB max	1 dB max
Isolation[2]	40 dB min	30 dB min

[1] *Measured for one signal line from leadframe to die attach pad.*
[2] *Measured for two opposite signal lines with all unconnected lines grounded.*

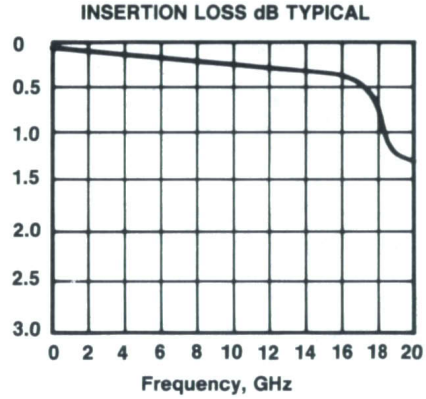
Environmentally Tested—per MIL-STD-883.

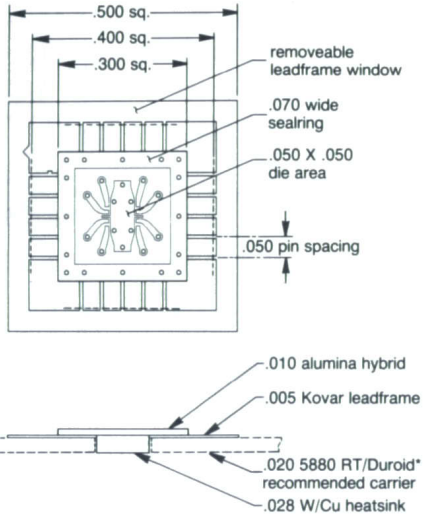
OTHER SERVICES AVAILABLE

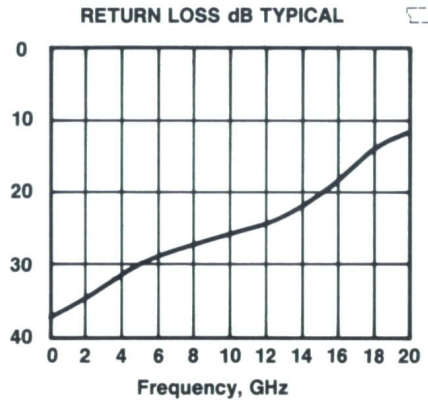
- Product Technology/Licensing
- Custom Design/Applications

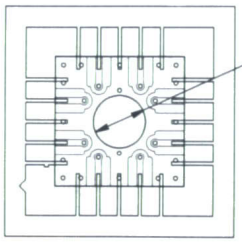
CONTACT

TekPAK Product Line
Microwave Technology Organization
Tektronix, Inc.
P.O. Box 500, 58-MTO
Beaverton, OR 97077
(503) 627-1299





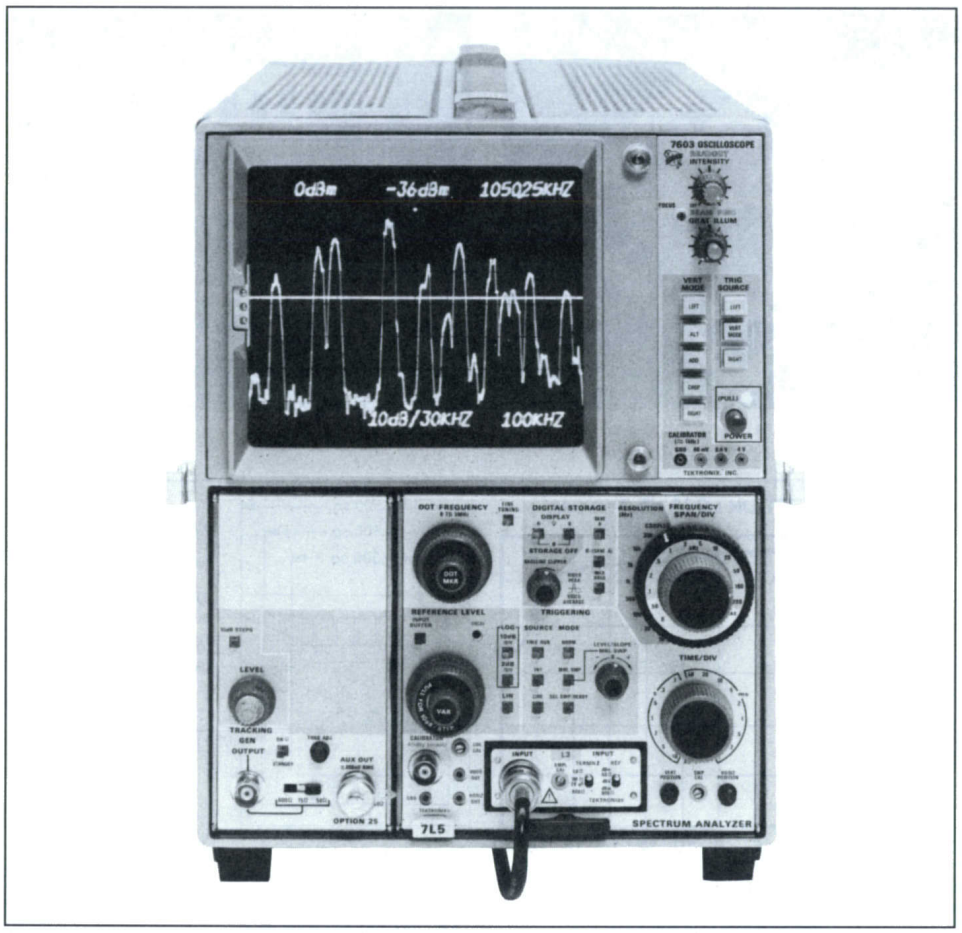




TPAK142 microwave IC hermetic surface-mount package

ORDERING INFORMATION

Product	Frequency Performance	Case Size (inches)	Motherboard Recommended	Diepad Area (inches)	Price	Options	Price
TPAK142	18 GHz	0.3 × 0.3	.020 5880 RT/Duroid	0.054 × 0.054	$46	Option 05—Leadframe window removed	$1
TPAK145	18 GHz	0.3 × 0.3	0.020 5880 RT/Duroid	0.096 × 0.096	$46	Option 40—Heatsink removed	– $2
TPAK155	14 GHz	0.3 × 0.3	0.031 5870 RT/Duroid	0.096 × 0.096	$44		
TKIT14E—Evaluation Kit for the TPAK 142					$499		



7L5 Option 25 Spectrum Analyzer with L3 (50 Ω, 600 Ω, 1 MΩ) plug-in module in a 7603 Option 06 mainframe with internal spectrum analyzer graticule. The L3-1 module (shown at upper right) is switch selectable to 75 Ω, 600 Ω or 1 MΩ.

7L5

- **Synthesizer Tuning**
- **Digital Storage and Averaging**
- **Three-Knob Operation**
- **Preset Reference Level and Dot Frequency for Extra Input Protection**
- **Swept Measurements (Option 25 Tracking Generator)**
- **Selectable Input Impedance; Calibration in dBm, dBV, or Volts/Division**
- **Semiautomatic Measurements With the Tek 7854**

The Tektronix 7L5 is a high performance, high value spectrum analyzer providing easy-to-use low frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak.

Digital storage proves particularly useful in the 7L5. With digital averaging and peak detection, you can accurately measure low level signals, such as intermodulation distortion products, in the presence of noise. With Max Hold, you can capture short duration signals and random transient phenomena that would otherwise be lost.

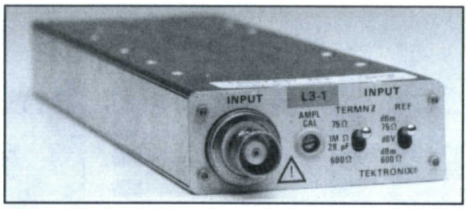
The 7L5 combines high performance with easy-to-use three-knob operation—

1) Set frequency span
2) Set center frequency
3) Set reference level. . .and measure!

Sweep speed and resolution bandwidth are set automatically.

Digital tuning and synthesizer stability let you set center frequency with six-digit accuracy immediately upon turn-on. Reference level can be set in 1 dB and 10 dB steps, eliminating the need to interpolate amplitude levels. And for measuring wide relative amplitude differences, the 7L5 offers 80 dB spurious-free display dynamic range.

The 7L5 makes accurate baseband communications measurements such as noise, spurious response, distortion, and transient interference, all with the certainty



of 10 Hz resolution. The 7L5 Option 25 provides swept frequency measurements from 20 Hz to 5 MHz. The tracking generator is built into a "three-wide" 7L5 plug-in analyzer.

This highly capable audio/baseband analyzer finds a place in many areas of use, including baseband evaluation of FM broadcast and television stereo signals, measurement of communications system basebands, power line distortion, EMC/RFI, and computer systems.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L5 Spectrum Analyzer. Specify 7L5 Option 12 for proper 7854 interface. Get full details from your Tek Sales Engineer or ask for Application Note 26W-5653.

CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer after a warm-up period of ten minutes.

FREQUENCY RELATED

Center Frequency Range—Input Frequency Range: 20 Hz through 5.0 MHz. Dot Frequency Range: 0 Hz through 4999.75 kHz tuned in 10 kHz or 250 Hz steps. Accuracy at 0 to 50 °C: ±(20 Hz $+10^{-5}$ of dot frequency). 20 to 30 °C: ±(5 Hz $+2\times10^{-6}$ of dot frequency).

Frequency Span/Division Range—50 Hz/div to 500 kHz/div (maximum) in a 1-2-5 sequence. Accuracy: Within 5%. Linearity: Within 5% over the center eight divisions. Zero Span: Provides fixed frequency operation for time domain display.

Resolution Bandwidth (6 dB)—10 Hz to 30 kHz in eight steps. Coupled position electronically couples resolution to span/division selection so that both are controlled by the same knob. Accuracy: Within 20% of resolution selected (30 Hz to 30 kHz). 10 Hz is 100 Hz ±20 Hz 70 dB down.

Resolution Shape Factor (60/6 dB)—10:1 or better for 10 Hz to 1 kHz and 5:1 or better for 3 kHz to 30 kHz.

Signal Level Change Between Any Two Bandwidths—30 kHz to 100 Hz: ≤ 0.5 dB. 30 kHz to 10 Hz: ≤ 2.0 dB.

Residual FM—≤ 1 Hz (p-p) for frequency span of 50 Hz/div to 2 kHz/div. ≤ 40 Hz (p-p) for frequency span of 5 kHz/div to 500 kHz/div.

Stability—≤ 5 Hz/hour.

AMPLITUDE RELATED

Display Modes—Log 10 dB/Division: Provides 80 dB display dynamic range. Accuracy is within 0.08 dB/dB to 2 dB maximum over 80 dB display dynamic range. Log 2 dB/Division: Provides 16 dB display dynamic range. Accuracy is within 0.15 dB/dB to 1 dB maximum over 16 dB display dynamic range.
LIN: 20 nV/div to 200 mV div in a 1-2-5 sequence. Accuracy is within 5%.
Reference Level—+21 to −128 dBm (50 or 75 Ω input impedance), +10 to −139 dBm (600 Ω input impedance), +8 to −141 dBV (1 MΩ input impedance). Calibrated in 1 and 10 dB steps.
Display Flatness—0.7 dB maximum from 20 Hz to 5 MHz (add 0.5% quantization error in digital storage).
Sensitivity—Equivalent input noise for each resolution bandwidth setting is measured in video average mode with 10 s/div sweep rate and input buffer control off. Sensitivity is degraded an additional 8 dB when the input buffer is on.

Resolution Bandwidth	Averaged Noise Level	
	dBm 50 Ω	dBV 75 Ω
10 Hz	−135 dBm	−140.5 dBV
30 Hz	−133 dBm	−138.5 dBV
100 Hz	−130 dBm	−135.5 dBV
300 Hz	−125 dBm	−130.5 dBV
1 kHz	−120 dBm	−125.5 dBV
3 kHz	−115 dBm	−120.5 dBV
10 kHz	−110 dBm	−115.5 dBV
30 kHz	−105 dBm	−110.5 dBV

SPURIOUS RESPONSES

Residual—≤ −143 dBV (noncalibrator related, referenced to the input).
Intermodulation Products—Within any frequency span for two on screen signals of any input level, third order down 75 dB or more and second order down 72 dB or more; of any input level up to −53 dBV or of any input level with input buffer on, second and third order down 80 dB or more.

GENERAL CHARACTERISTICS

Sweep—Triggered, manual, auto.
Sweep Time—10 s/div to 0.1 ms/div in a 1-2-5 sequence.
Accuracy—Within 5% of selected time/division.
Triggering—Sources are free run, internal and line. Modes are normal, manual sweep and single sweep.
Sensitivity—≥1.5 div of internal signal for both normal and single sweep modes over the approximate frequency range of 30 Hz to 500 kHz.
Shipping Weight—7.6 kg (17 lb).

INPUT SIGNALS

Maximum Input Power Level—1 MΩ/28 pF: 15 V (p-p) for ac or pulse signals with rise times of 2 V/μs or faster (pulses or ac beyond this specification may open an input fuse). 40 V (dc plus peak ac) for signals with rise times slower than 2 V/μs. 600 Ω (Internally Terminated): 12 V dc or RMS (+24 dBm). 50Ω (Internally Terminated): 3.5 V dc or RMS (+24 dBm).
Input Impedance—Switch selectable 1 MΩ in parallel with 28 pF, 50Ω (75Ω for L3 Option 01) termination, or 600 Ω termination.

OUTPUT SIGNAL

Calibrator—(Cal Out) 500 kHz squarewave within ±0.15 dB of −40 dBV into the plug-in impedance.
Video Out—50 mV/div ±5% (about the CRT center) with source impedance of 1 kΩ.
Horizontal Out—0 V dc to about −6 V dc sawtooth with a source impedance of 5 kΩ.

Option 25 Tracking Generator

The 7L5 with Option 25 Tracking Generator provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 20 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a threewide unit for the 7000 Series mainframes.

CHARACTERISTICS

Frequency—Range 20 Hz to 5.0 MHz.
Output Impedance—50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.
Amplitude—The output level is calibrated in dBm or dBV and selectable in 10 or 1 dB steps. A vernier provides continuous variation between calibrated steps.
Range 50 Ω: 0 to −63 dBm. 75 Ω: −6 to −69 dBm. 600 Ω: −17 to −80 dBm.
Accuracy (Maximum Output Calibrated at 500 kHz)—50 Ω: 0 dBm ±0.25 dB. 75 Ω: −6 dBm +0.4, −0.2 dB. 600 Ω: −17 dBm +0.5, −0.1 dB.
Attenuator—Range: 0 to 63 dB in 10 dB or 1 dB steps. Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.
Flatness—50 and 75Ω: Within 0.5 dB p-p. 600 Ω: Within 1.0 dB p-p. Total System Flatness (7L5 with L3 Plug-In Module and Option 25) 50 and 75Ω: Within 1.0 dB p-p. 600 Ω: Within 1.25 dB p-p.
Dynamic Range (7L5 With Option 25)—≥110 dB.
Residual FM (p-p)—(7L5 with Option 25). Spans to 2 kHz/Div: 2 Hz. Spans 5 kHz/Div or Greater: 40 Hz.
Stability—25 Hz/5 minutes after ten minute warm-up decreasing to 25 Hz/hour maximum after one hour.
Spurious Suppression, 20 Hz to 5.0 MHz (Harmonic and Nonharmonic)—40 dB or more with respect to the carrier.
Auxiliary Output—≥ 200 mV RMS into 50Ω.

BALANCED INPUT TRANSFORMER

Frequency Range—50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.
Flatness—0.25 dB p-p maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.
Common-Mode Rejection—25 dB minimum (50 kHz to 3 MHz).
Output Termination—Switchable between 124 Ω, 135 Ω, and none for bridging or external termination.
Connectors—WECO (0.37 in with 0.090 center) on 0.625 inch spacing for balanced input. BNC for single-ended output.

ORDERING INFORMATION

7L5 Spectrum Analyzer (Requires L3 Plug-In Module). **$12,500**
Includes: Spectrum analyzer graticule (337-1159-00); (7000 Series), and (337-1439-01); (7603), light blue filter (378-0684-00); operator manual (070-1734-01); service manual (070-2184-01).

OPTIONS

Option 11—L3 Plug-In Module Option 01 shipped with 7L5. **+$1,775**
Option 12—7854 Waveform Oscilloscope compatibility. **+$165**
Option 20—L3 Plug-In Module shipped with 7L5. **+$1,775**
Option 25—Tracking Generator. **+$1,765**
L3 Plug-In Module, 1 MΩ, 50 Ω, 600 Ω. **$1,775**
Includes: Instruction manual (070-2154-02).
Option 01—(L3 only) 1 MΩ, 75 Ω, 600 Ω. **NC**

CONVERSION KIT

Tracking Generator—To add to existing 7L5. Order 040-0810-04 **$2,345**

RECOMMENDED MAINFRAMES

7603*1 Oscilloscope, 100 MHz, see page 254. **$4,235**
R7603*1 Rackmount Oscilloscope, 100 MHz, see page 254. **$4,805**
7854 Waveform Processing Oscilloscope, 400 MHz (see page 372) **$15,275**
*1 *Suggested oscilloscope.*

OPTIONS (7603/R7603)

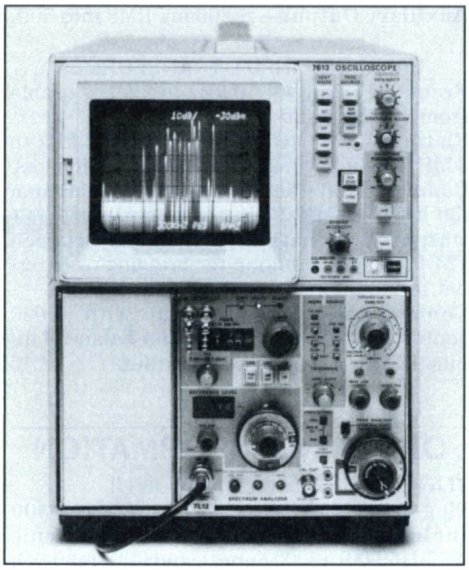
Option 06—Internal Spectrum Analyzer Graticule. **+$50**
Option 08—Protective Front Cover (7603 only). **+$115**
Option 77—GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

OPTIONAL ACCESSORIES

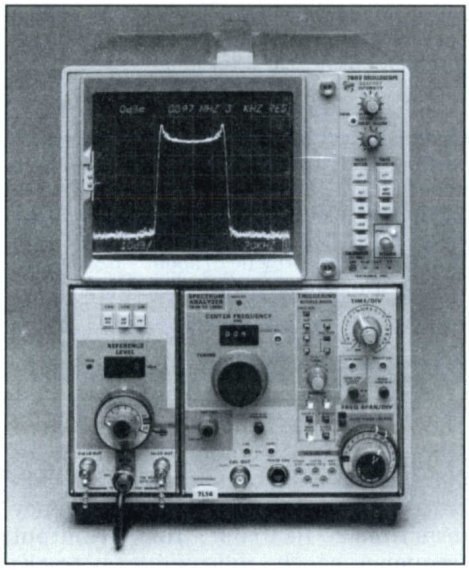
75 to 50 Ω Minimum Loss Attenuator—AC coupled. Order 011-0112-00 **$60**
P6105A—10X, 2 m Probe. **$93**
Balanced Input Transformer—Order 013-0182-00. **$310**

TRAINING

Tektronix offers service training classes on the 7L5 Spectrum Analyzer. For further training information, contact your local Sales/Service Office.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence mainframe with internal spectrum analyzer graticule.



7L14 in 7603 mainframe with internal spectrum analyzer graticule.

7L12

- **Proven, Economical VHF/UHF Coverage**
- **Automatic Phase Lock 300 Hz to 3 MHz Resolution Bandwidth Range**
- **Swept Measurements with the TR 502**
- **Coverage to 2.5 GHz (Option 39)**
- **Semiautomatic Measurements with the Tek 7854**

The Tek 7L12 Spectrum Analyzer (100 kHz-1.8 GHz) is a proven, economical performer and very popular among users across a range of applications including AM, FM and TV Broadcasting, two-way radio, and other communications systems testing. The 7L12 is also very useful in EMC and other VHF/UHF applications. By ordering Option 39, the 7L12 may be used to 2.5 GHz.

Performance you can count on includes 300 Hz resolution bandwidth/automatic phase lock stabilization, 70 dB spurious-free dynamic range and a very stable swept measurement capability (100 kHz to 1.8 GHz) using the TR 502 (see page 201). Ease-of-use features include CRT readouts of key parameters, and fully calibrated displays.

The 7L12 is fully compatible with the Tek 1405 TV Sideband Analyzer (see page 201) permitting on-the-air transmitter evaluation.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L12 Spectrum Analyzer. The 7854 can also be put to work with your choice of other Tektronix 7000 Series test and measurement plug-ins—versatility plus! Get full details from your Tek Sales Engineer or ask for Application Note 26W-5653.

7L14

- **Resolution Bandwidth Range of 30 Hz to 3 MHz**
- **−130 dBm Sensitivity**
- **Swept Measurements with the Tek TR 502**
- **1 kHz to 2.5 GHz Coverage with Option 39**
- **Compatibility with 1405 TV Sideband Analyzer**
- **Semiautomatic Measurements with the Tek 7854**

The Tektronix 7L14 provides high performance spectrum analysis in the 10 kHz to 1.8 GHz range. Option 39 increases coverage to 1 kHz to 2.5 GHz. Option 23—deleting the built-in input limiter—results in 1 kHz to 1.8 GHz coverage.

7L14 capability translates to confidently making communications systems or EMC measurements. Narrow 4:1 or less resolution bandwidth filter shape factor (12:1 at 30 Hz) and 13 Hz p-p residual FM mean you can effectively examine close-in spurs or sidebands. Combined with the Tek TR 502 Tracking Generator, the 7L14 is the heart of a very stable scalar analysis system available at an affordable price. Check RF networks, filters, amplifiers, and more. . .see page 201 for details.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L14 Spectrum Analyzer. The 7854 Mainframe can also be used with your choice of other Tek 7000 Series test and measurement plug-ins—versatility plus! Get full details from your Tek Sales Engineer or ask for Application Note 26W-5653.

ORDERING INFORMATION

7L12 Spectrum Analyzer **$12,500**
Includes: Spectrum analyzer graticule, clear plastic implosion shield with LOG, LIN, REF, and F (frequency) direction markings (337-1439-01) for 7603 scopes, and (337-1159-02) for other 7000 Series scopes; light filter (378-0625-07); amber light filter (378-0684 01); 6 foot 50Ω coax cable with BNC connectors (012-0113-00); BNC Male to N Female adaptor (103-0058-00); instruction manual (070-1298 02).

7L14 Spectrum Analyzer **$19,825**
Includes: Spectrum analyzer graticule, 6 ft 50Ω coax cable with BNC connectors (012-0113-00); BNC male to female adaptor (103-0058-00); light filter (378-0625-07); amber light filter (378-0684-01); clear plastic implosion shield with Log, Lin, Ref, and F (frequency) direction markings (337-1439-01), for 7603 scope and (337-1159-02) for other 7000 Series scopes; instruction manual (070-3434-00).

OPTIONS

Option 23—(7L14 only) Deletes input limiter. **+$50**
Option 39—Extended Frequency Range.
(7L12) 100 kHz to 2.5 GHz. **+$750**
(7L14) 1 kHz to 2.5 GHz. **+$750**

RECOMMENDED MAINFRAMES

The 7603/R7603 and 7854 are the only oscilloscopes recommended for the 7L14. The 7613/R7613, 7603/R7603, and 7854 are all recommended for the 7L12.

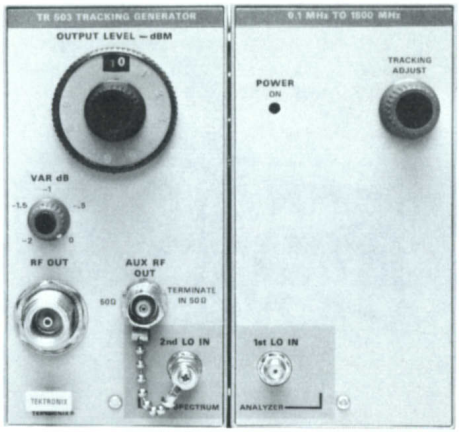
7613 Storage Oscilloscope, 100 MHz. **$6,965**
R7613 Rackmount Storage Oscilloscope, 100 MHz. **$7,490**
7603 Oscilloscope, 100 MHz. **$4,235**
R7603 Rackmount scope, 100 MHz. **$4,805**
7854 Digitizing scope, 400 MHz. **$15,275**

OPTIONS (7603/R7603, 7613/R7613)

Option 06—Internal Spectrum Analyzer Graticule. **+$50**
Option 08 —Protective front cover (cabinet only). **+$115**
Option 77—(7603/R7603 only) GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

OPTIONAL ACCESSORY (7L12 only)

Blank Plug-In Panel—Order 016-0155-00. **$60**



TR 502/TR 503

Tracking Generators

- **Swept Measurements to 1.8 GHz**
- **Enhances Dynamic Range to Better Than 110 dB**
- **Very Stable—Resolve Signals Using 30 Hz Resolution Bandwidth**
- **Auxiliary, Constant-Level Output Provides for Frequency Counter Measurement Even of Signals at the Noise Floor**

CHARACTERISTICS

	TR 503/All 490 Series and 2750 Series	TR 502/7L14	TR 502/7L12
Frequency Range	100 kHz –1.8 GHz	100 kHz –1.8 GHz	100 kHz –1.8 GHz
Output Level	(Max) 0 dBm ±0.5 dB	0 dBm ±0.5 dB	0 dBm ±0.5 dB
Range	0 to –59 dB in 10 dB and 1 dB steps	0 to –59 dB in 10 dB and 1 dB steps	0 to –59 dB in 10 dB and 1 dB steps
Flatness	Within ±2.25 dB Max from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±2.4 dB maximum from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±3.0 dB maximum from 100 kHz to 1.8 GHz (Typically ±2.0 dB)
Dynamic Range	≥110 dB	≥110 dB	≥100 dB
Residual FM	50 Hz p-p	13 Hz p-p	200 Hz p-p
Output Impedance	50 Ω Nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz
Auxiliary Output	0.1 V RMS into 50 Ω load –7 dBm minimum	0.1 V RMS into 50 Ω Load	0.1 V RMS into 50 Ω Load
Spurious Signoff	Harmonic: –20 dBc Nonharmonic: –40 dBc	Harmonic: –20 dBc Nonharmonic: –40 dBc	Harmonic: –20 dBc Nonharmonic: –40 dBc

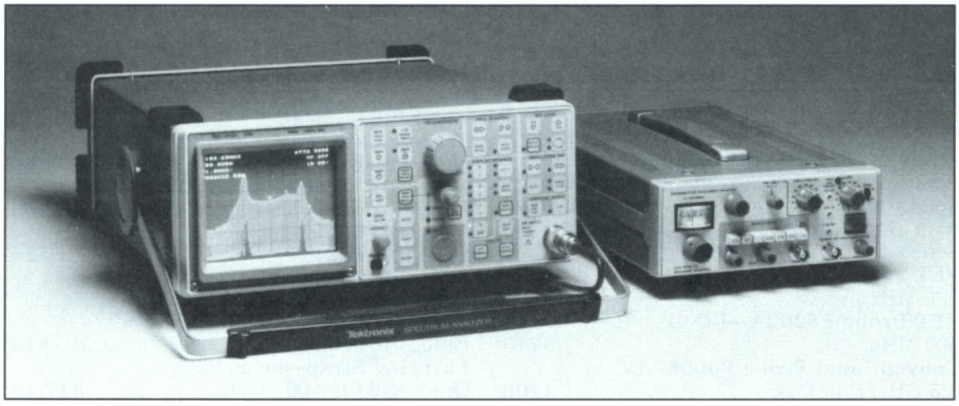
ORDERING INFORMATION

TR 502 Tracking Generator **$7,080**
Includes: Two 50 Ω coax cables (012-0649-00); logic interface cable (012-0648-00); N male to BNC female adapter (103-0045-00); retainer plug-in (343-0604-00); 3 mm male to BNC female adapter (015 1018-00); instruction manual (070-1735-00).

TR 503 Tracking Generator **$7,080**
Includes: Same as TR 502 except no logic interface cable and instruction manual (070-3526-00).

OPTIONAL ACCESSORIES

TM 503—Power Module. **$400**
TM 504—Power Module. For use with TR 50X, DC 509, and DP 501. **$590**
DC 509 Option 01—Digital Counter with high stability time base. **$2,275**
DP 501—Digital Prescaler. **$585**
Blank Panel—Order 016-0195-03 **$33**
10 dB, 3 mm Attenuator—Used in the 2nd LO input line to improve TR 502/7L12 Isolation. Order 307-0553-00 **$50**



1405 TV Sideband Adapter

- **Facilitates In-Service Testing of Transmitter**
- **Measure Transmitter Frequency Response to ±0.2 dB**
- **Video Circuits Can be Swept**
- **For In-Service Testing, Use of External Blanking Allows Either Full Field or Single Line Operation**
- **Check Aural Fm Deviation With Built-In Bessel Null Technique**
- **Flexible Marker System Will Accept Standard Crystals**

To analyze the sideband response of a television transmitter, the 1405 Sideband adapter is recommended for use in tandem with the Tektronix 2710, 7L12, 7L14, 2750, and 490 Series Series spectrum analyzers. It generates a composite video signal, which is applied as modulation to a television transmitter. The output is displayed on the spectrum analyzer and appears as a response curve, to within ±0.2 dB, of the transmitter being tested.

The 1405/Spectrum Analyzer combination will display frequency response characteristics of RF and IF circuits for transmitters with frequencies to 1 GHz. Video circuits can also be analyzed.

Correct frequencies at the TV Channel marks on the dial readout for 490 Series and 2750 Series Spectrum Analyzers are provided with Option 02, and for the 2710 Spectrum Analyzer with Option 03.

Request Tek Brochure 26W-4787-1 for complete specifications or call your local sales engineer for additional information.

ORDERING INFORMATION

1405 TV Sideband adapter 525/60 Markers **$5,780**
Includes: Instruction manual (070-2078-00).

OPTIONS

Option 01—TV Sideband adapter (625/50 Markers). **+$200**
Option 02—Dial Readout for 490/2750 Series Spectrum Analyzers. **NC**
Option 03—Dial Readout for use with 2710 Spectrum Analyzer. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

RACKMOUNT CONVERSION KIT

Standard 19-inch rack.
Order 016-0489-00 **$475**

POWER SPLITTER

75 Ω/50 Ω BNC Output, 50 Ω BNC Input—Order 067-1232-00 **$250**

CABLES, PADS AND ADAPTORS

50 Ω Coaxial Cable—BNC to BNC 5.5 in. Order 012-0214-00 **$50**

50 Ω Coaxial Cable—BNC to BNC Conn, 18 in. Order 012-0076-00 **$17.50**

50 Ω Coaxial Cable—BNC to BNC Conn, 42 in. Order 012-0057-01 **$18.50**

75 Ω Coaxial Cable—BNC to BNC Conn, 42 in. Order 012-0074-00 **$19**

75 Ω to 50 Ω Minimum Loss Attenuator—With dc block, 5.7 dB loss. Order 011-0112-00 **$60**

75 Ω to 50 Ω Matching Attenuator—With 11.25 dB conversion factor from dBm to dBV with dc block. Order 011-0118-00 **$75**

Fixed 10 dB Attenuator—With 3 mm fittings for use with TR 502 with 7L12. Order 307-0553-00 **$50**

"F" Female to BNC Male adapter—Order 013-0126-00 **$18.75**

BNC Female to "F" Male adapter—Order 103-0158-00 **$10.75**

"N" Female to BNC Male adapter—Order 103-0058-00 **$8.75**

BNC Female 75 Ω to N Male 50 Ω adapter—Order 103-0273-00*1

Pin to BNC Cable for 7000 Series Spectrum Analyzer—Order 175-1178-00 **$42**

DC BLOCKS

N(F) to N(M)—10 kHz to 21 GHz, 50 V dc maximum. Order 015-0509-00 **$250**

DC Block 015-0509-00 is rated over the coaxial frequency range of 10 kHz to 21 GHz. Its electrical characteristics, rugged construction, and type "N" connectors make it the preferred solution for EMI/RFI and other applications requiring the blocking of 275X and 49X front ends.

Characteristics—Operating Frequency: 10 kHz to 21 GHz. Insertion Loss: 1.0 dB maximum. VSWR: 1.4:1 maximum, 10 kHz to 18 GHz; 1.6:1 maximum 18 to 21 GHz. Voltage Rating: 50 V dc maximum. Impedance: 50Ω. Construction: Passivated Stainless Steel. Connectors: Type "N" male and female per MIL-C-39012. Dimensions: 2.15×0.84 (dia.) inches maximum.

BNC to BNC—Maximum dc potential 50 V. Order 015-0221-00 **$105**

PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe.

7000 Series 3 Hole Mainframe Cover—Order 016-0192-01 **$20**

7000 Series 4 Hole Mainframe Cover—Order 016-0531-00 **$15**

2750/490 Series Rear Panel Connector Cover—Order 337-3274-00 **$5**

RIGID FRONT COVERS

Solid snap-on or friction fit covers are available to protect the instruments in transit or field use. See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613.

Protective Front Cover for existing 7603 or 7613 mainframes:

Blue—Order 040-0835-00 **$210**

Gray—Order 040-0628-00 **$185**

Rain Cover—for 2710. Order 016-0848-00 **$15.25**

GRATICULES, FILTERS

Plastic Implosion Shield and Spectrum Analyzer Graticule—7613 and 7623 Mainframes. Order 378-0625-07 **$14.50**

Plastic Implosion Shield and Spectrum Analyzer Graticule—7403 and 7603 Mainframes. Order 337-1439-01 **$8.50**

Plastic Implosion Shield and Spectrum Analyzer Graticule—For all other 7000 Series mainframes. Order 337-1159-02 **$8.50**

(Internal graticules are available with most 7000 Series mainframes).

EMC Metal Screen Mesh Filter—For 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 instruments. Order 378-0603-00 **$75**

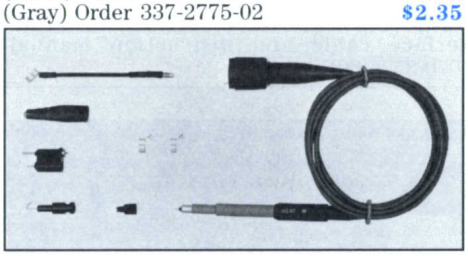
EMC Metal Screen Mesh Filter—For 7400 Series and 7603 instruments. Order 378-0696-00 **$70**

Complete selection of colored filters is available in the Accessories section, page 535.

CRT Light Filter—for 2710.

(Clear) Order 337-2775-01 **$1.95**

(Gray) Order 337-2775-02 **$2.35**



PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L5, 7L12, 7L14, and all 2750/490 Series spectrum analyzers.

FET Probe P6201—DC to 900 MHz. **$1,280**

FET Probe P6202A—DC to 500 MHz. **$715**

Conventional Probe P6056—DC to 3.5 GHz, 6 ft. **$200**

Conventional Probe P6057—DC to 1.4 GHz, 6 ft. **$195**

Current Probe P6022—DC to 150 MHz. **$495**

Complete specifications are available in the Probes and Accessories Section, page 475.

CAMERAS

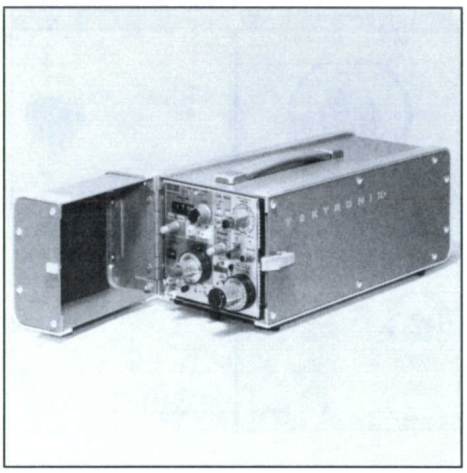
A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 7000 and 2750/490 Series spectrum analyzers are:

C-59AP—General Purpose Camera **$1,375**

Camera C-5C Option 02—With 016-0359-01 adapter hood **$465**

C-4 Option 02—Low Cost Camera **$370**

Complete specifications on all cameras are available in the Camera section.



CARRYING CASES AND MOUNTS

Specialized carrying cases are available in two forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L5, 7L12, or 7L14 plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

Securing Kit—Fits 7L12 or 7L14. Order 016-0637-00 **$65**

3-Wide Carrying Case—For 7L14, 7L5 Option 25. Order 016-0626-00 **$390**

2-Wide Carrying Case—For 7L12, 7L5. Order 016-0625-00 **$330**

Luggage-Type Carrying Case—For 7603 Option 08, 7613 Option 08. Order 016-0628-00 **$580**

(Analyzer must have 016-0637-00 Securing Kit) **$65**

Hard Case—Transit for the 490 Series. Order 016-0658-00 **$795**

Soft Case—For the 490 Series. Order 016-0659-00 **$130**

Transit Case—for 2710. Order 016-0792-01 **$360**

MISCELLANEOUS

K212—Portable Instrument Cart. **$350**

Manual—Service for 2710. Order 070-6024-00 **$25**

Accessory Pouch—for 2710. Order 016-0677-00*1

Viewing Hood—for 2710. Order 016-0566-00 **$19**

Carrying Strap—for 2710. Order 346-0199-00 **$17.50**

Diplexer Assembly—For use with 2750/490 Series Spectrum Analyzers and WM490 Series Waveguide Mixers. Includes TNC to SMA adapter, cable and SMA semi-rigid coax. Order 015-0385-00 **$210**

Your local Sales Office or representative can quote prices and availability on any of these accessories.

Numerous Application Notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMC, AM, FM, two-way radio and television measurements, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Sales Office or representative.

INSTRUMENTS/SYSTEMS PRODUCTS

CONTENTS

Reference 204
Technical Assistance Services . . 216
Custom Measurement Systems . . 217
Customer Training 219
Laboratory Oscilloscopes 222
Portable Oscilloscopes 300
Automated Test Systems Instruments 353
Digitizers 354
Controllers/Software 392
Acquisition/Processing Packages 400
Curve Tracers 406
Signal-Routing Instruments 420
Modular Instruments 434
Cameras 476
Digital Photometer/Radiometer . . . 497
Carts 502
Probes 505
Isolation Measurement Accessories 529

Broadest Selection

We've added new capabilities to the world's broadest selection of portable and laboratory oscilloscopes, programmable and manual general-purpose instruments, waveform digitizers, systems, and accessories

These additions illustrate our continuing commitment to make your time and resources more productive. Here are some examples:

Analog and Digitizing Oscilloscopes

The programmable 11000-Series mainframes and plug-ins bring a new standard to the world of analog and digitizing oscilloscopes. These oscilloscopes provide unparalleled versatility and operator convenience. The 11402 digitizing oscilloscope provides 1-GHz bandwidth, long record lengths, and extensive on-board waveform processing. The 11302 analog mainframe, with its microchannel-plate CRT, provides 500-MHz analog bandwidth and visual display of hard-to-see low-repetition-rate transients in the fastest signals.

The NEW 7250 Transient-Digitizing Oscilloscope offers 6-GHz bandwidth and easy, menu-driven operation. It can capture single-shot events up to its maximum bandwidth.

Software

GURU II supplies the important communication link between an IBM PC (or compatible) and GPIB instrumentation.

The Signal Processing and Display (SPD) software product provides a useful library of over 190 complex functions callable from compiled test programs or from a menu-driven interface. SPD can be used in conjunction with an IBM PC or Tek digitizers to develop specialized measurement systems.

ASYST Scientific Software turns your IBM PC, XT, or AT into a complete scientific workstation. Integrated graphics, analysis, and data acquisition provide a powerful tool to analyze measurements made with Tektronix GPIB programmable instrumentation.

Optical-Electrical Converters for the 11000 Series

The NEW P6701 and P6702 optical-to-electrical converters cover the spectral range from 450 to 1700 nm and have a frequency response of 700 and 500 MHz, respectively. The compensation-box-size probes mount directly to the 11000-Series amplifier inputs, enabling the oscilloscope to act as an average or pulse power meter as well as a powerful high-speed optical-waveform analyzer. The P6751 Spatial Input Head allows free-space optical signals (e.g., laser beams) to be captured by the P6701 or P6702.

Portable Oscilloscopes

The 350-MHz 2467 Oscilloscope features 4-div/ns visual writing rate, the fastest among portable scopes. Tek's exclusive microchannel-plate CRT makes it possible to see single-shot, 1-ns pulse transitions in normal room light at 500-ps/div sweep speeds.

The 2445A/2465A family has higher bandwidth (2465A only) and new auto set-up, instant recall, and set-up sequencing. Optional GPIB compatibility, digital timer/counter, digital multimeter, and video-measurement capabilities enable this family of scopes to meet many service and bench test-and-measurement needs.

The General-Purpose Scope (GPS) family includes the 2245 and 2246. These scopes feature four vertical channels, flexible triggering, extensive CRT readouts, and pushbutton ease of use. Channels 3 and 4 are optimized for logic signals.

The NEW 2430A brings the best features of the industry-standard 2400 Series into the digital world, including auto setup, waveform-parameter extraction, and setup sequencing. Tek's patented feature, Save on Delta, provides unattended pass/fail testing. The 2230, 2220, and NEW 2221 all feature 4K record lengths, 100-ns peak detection, and optional GPIB or RS-232C interfaces.

Waveform Acquisition and Signal Analysis

Joining Tek's established line of waveform-acquisition products is the NEW Sony®/Tektronix® RTD 710. This state-of-the-art, dual-channel digitizer provides an unprecedented combination of speed, accuracy, and record lengths for capturing fast transients. Advanced triggering techniques, sample-rate switching, and built-in waveform analysis are but a few of its features. Also, you can combine all the power of the RTD 710 into a complete computer-controlled waveform acquisition and analysis package with the MP 1701 and MP 2701 Measurement Packages.

Switching and Interfacing Solutions

For the first time, complete signal routing and DUT interfacing solutions can be configured from a single family of products, the TSI 8150. This family of off-the-shelf components spans a broad range of voltage, current, and frequency capabilities, and provides unprecedented switching versatility and DUT interfacing capabilities.

Curve Tracer

The NEW Sony®/Tektronix® 371 High-Power Programmable Curve Tracer is a high-power version of the versatile 370 Curve Tracer. The 371 is capable of measuring, displaying, and storing the characteristics of a wide variety of high-power devices, including bipolar transistors, FETs, MOSFETs, and SCRs. Stored and nonstored curves can be stored simultaneously.

CONTENTS

Technical Assistance Services .. 216
Custom Measurement Systems .. 217
Customer Training 219
Laboratory Oscilloscopes 222
11000-Series Instruments 222
7000-Series Instruments 243
7000-Series Nonstorage Mainframes 248
7000-Series CRT-Storage Mainframes 258
7000-Series Plug-Ins 264
7000-Series Sampling Systems 278
5000-Series Instruments 287
Portable Oscilloscopes 300
Portable Nonstorage Scopes .. 303
Portable Storage Scopes 346
Automated Test Systems Instruments 353
Digitizers 354
Digital-Storage Oscilloscopes . 354
Digital Camera System 390
Controllers and Peripherals 392
Software
TekMAP 374
ASYST 376
SPD 378
TEK EZ-TEST 397
GURU II 398
System Support 392
Measurement Packages
Desktop Controller-Based Acquisition/Processing Measurement Packages 400
Curve Tracers 406
Signal-Routing/DUT Interfacing Products 420
TSI 8150 Test System Interface 421
MI 5010/MX 5010 Programmable Multifunction Interface and Extender 428
SI 5010 Programmable Scanner 432
1360P/1360S Programmable Multiplexer 433
Modular Test and Measurement Instruments 434
Counter/Timers 436
Digital Multimeters 441
Function Generators 444
Digital Delay 449
Pulse Generators 450
Power Supplies 452
Distortion Analyzer 457
Oscillators 458
Current Amplifier, Probes 461
Amplifiers 461
Plug-In Oscilloscopes 462
Oscilloscope Calibration Generators 465
Mainframes and Accessories 470
Accessories 475
NEW Opto-Electrical Converters 496
Digital Camera System 476
Video Hard Copiers/Plotters ... 478
Cameras 480
Digital Photometer/Radiometer 497
Carts 502
Probes 505
Isolation Accessories 528
Probe Accessories 530
Adapting/Connecting Accessories 533
Mounting/Viewing Accessories 535
REFERENCE INFORMATION
Modular and Integrated Oscilloscopes 204
Programmable General-Purpose Instruments 205
Understanding Oscilloscope Specifications 206
Choosing a CRT Phosphor 208
Storage Oscilloscopes 209
Digital-Storage Oscilloscopes ... 212
Sampling Oscilloscopes 214
Waveform Digitizers 215
Automated Test System 353
Acquisition/Processing Measurement Packages 400
Choosing a Scope Camera 483
Choosing a Probe 508
Making Floating Scope Measurements 528

A BROAD PRODUCT LINE

Tektronix designs, manufactures, markets, supports, and services test-and-measurement products worldwide. Our test-and-measurement instruments and systems are used by scientists, engineers, and technicians in basic research, product design, manufacturing test, training, maintenance, and service applications in a broad range of industries and public institutions.

Products include:

- Fully automated desktop, controller- and minicomputer-based acquisition/processing systems.
- Easy-to-use programmable 11000 Series, equally at home on the engineer's bench and in the most complex automated test systems.
- The NEW 7250 Transient Digitizing Oscilloscope provides 6-GHz bandwidth—the highest available in a laboratory oscilloscope.
- High-performance laboratory 7000-Series plug-in instruments.
- The 5000-Series instruments, which continue the 7000-Series concept of flexibility and expandability with a line of plug-ins and mainframes for the cost-conscious user.
- Complete line of portable oscilloscopes that range from handheld, battery-operated miniscopes to full-featured, high-performance instruments that have become the standards against which all other portables are measured.
- Two modular and compact product lines of general-purpose instrumentation, including the cost-effective TM 500s and the GPIB compatible and programmable TM 5000s.
- The industry's most complete selection of passive and active signal-acquisition products, optimized for high-integrity transmission of signal intelligence from the device under test to the measurement instrument or system.
- Curve tracers that acquire complete information about a multitude of semiconductor devices and integrated circuits and present it in a quickly comprehensible display.
- A portable digital photometer/radiometer with eight interchangeable probes for measuring illuminance, irradiance, luminance, LED output, and relative intensity.
- Accessories, from cameras to isolation measurement devices, that support not only all Instruments products, but also many Tek Design Automation, Information Display, and Communication products.
- Digital Camera System that provides waveform capture and analysis up to the writing speed of an analog oscilloscope.

MODULAR AND INTEGRATED INSTRUMENTS

There are two basic configurations for test-and-measurement instruments: modular and integrated. Modular instruments, also called "plug-in" or "laboratory" models, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments (also called "monolithic") are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all integrated instruments are portable, and some modular systems (such as scopes within the Tektronix TM 500 Instrument line) are designed for easy transport.

Modular Design Advantages

Examples of modular design in Tektronix Instrument products include the 11000 Series, 7000 Series, 5000 Series, TM 500 General-Purpose Instruments, and TM 5000 Programmable General-Purpose Instruments.

Versatility is the prime advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit are available by choosing the right plug-ins. Plug-ins can also extend the original instrument's range of functions. Digital counter/timers, curve tracers, and spectrum analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscope mainframes.

Performance is another advantage. In the case of the 11000-Series and 7000-Series instruments, modularity gives you the maximum performance available in an oscilloscope. Also, modularity allows you to upgrade your instruments to take advantage of advances in technology.

Modular instruments can often be very cost effective too, because within a given product line, they can be shared. For example, the TM 500 test-and-calibration plug-ins, used in the lab for design work, can be inserted into a portable mainframe and easily carried to the site of a service problem. As another example, a few high-performance laboratory plug-ins from the 7000 Series can be shared among several 7000-Series mainframes.

Consider the versatility and performance advantages as you read about the wide range of Tektronix modular instruments.

Integrated Design Advantages

Integrated instruments are often optimized for a single range of functions. One-piece instrument design can provide reductions in weight, increased ease of use, smaller size, lower power requirements and, often, higher performance/price ratios for your key requirements.

Portability can be essential for some test-and-measurement applications, and in these cases, an integrated design is often the best choice. Because a wide variety of options and optional accessories extend their ranges of applications, versatility can also be a feature of Tektronix integrated instruments.

Tektronix integrated scopes, either portable or rackmounted, are instruments where the design emphasis is often on the factors of economy, ruggedness, environmental protection, and internal or external battery power.

TM 500 MANUAL INSTRUMENTS

The Tektronix TM 500 line is a modular system. One-, two-, three-, four-, five-, and six-compartment mainframes accept a broad selection of plug-in instruments. The mainframe provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as important, TM 500 mainframes also provide signal control and data interface between instrument modules. This allows TM 500 instruments to work either individually or together as integrated measuring systems. The Tektronix TM 500 Instrument line is extensive—more than 30 instruments, including digital multimeters, counter/timers, power supplies, signal sources, oscilloscopes, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can easily apply TM 500's capability to unusual applications.

The TM 500 instrument line has several configurations designed for portability. The TM 515 Traveler Mainframe, attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat on most airlines), is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. The TM 503 three-compartment mainframe or the TM 504 four-compartment mainframe, with carrying case or protective cover, provide additional portability for the TM 500 instruments. Again, relatively lightweight, rugged construction, and convenient size are the keys to portability.

TM 5000 GPIB PROGRAMMABLE INSTRUMENTS

The Tektronix TM 5000 products extend the TM 500 concept of configurability to a line of IEEE Standard 488 compatible, fully programmable measurement, stimulus, and interfacing instruments. Tek's TM 5000 programmables are the easiest IEEE Standard 488 test-and-measurement instruments you can use. Because they are compatible with our TM 500 line of modular instruments, it is possible to configure literally hundreds of customized systems—systems that are programmable, manual, or hybrid with plug-in, plug-out ease.

Tek's *Standard Codes and Formats* make communication between TM 5000 instruments easier than ever before. This same set of *Standard Codes and Formats* is used to communicate with other Tektronix IEEE Standard 488 instruments, such as the 2400-Family Oscilloscopes and 490P-Series Spectrum Analyzers. TM 5000 commands are mnemonic. Each bus command is in "standard engineering English," matching the front-panel nomenclature—ideal for the programmer who realizes the frustrations of working with many of today's instruments.

With the Learn Mode, one keystroke transfers a complete front-panel setup to the controller for storage in memory. This greatly increases the productivity of the engineer by reducing set-up time where test settings are constantly changing. You can change a routine without having to reprogram the whole system.

All TM 5000 programmables have diagnostics capability designed right in. They perform self-test on power-up, and indicate an error if a malfunction has occurred. Plus, they've all been designed for fast troubleshooting using signature analysis. All are UL listed.

As with TM 500, TM 5000 programmable systems take up less than half the space of standard rackmount equipment. This size advantage really pays off on the bench, on the manufacturing floor, or in the field, where portability is essential.

GPIB and RS-232C OSCILLOSCOPES

Tektronix has several oscilloscopes from which to choose for GPIB capability. The Tektronix 11000 Series—the 11301 and 11302 analog mainframes, the 11401 and 11402 digitizing mainframes, and their associated plug-in units—provide both GPIB and RS-232C interfaces as standard features. These instruments and the 7854, 7250, 2465A/2445A, 2220, 2221, 2230, 2430A, 2467, 336, and 5223, with their respective GPIB features and options, give you an opportunity to improve the consistency of measurements and to control costs. A GPIB system controller can consistently repeat a defined sequence of tests while the operator concentrates on the task instead of the tools. A system comprising a GPIB controller and programmable oscilloscope offers complete automation of many measurements.

The NEW 2430A, with full programmability and waveform-parameter extraction, provides accurate and immediate answers to the system controller. Measurements like rise time, fall time, frequency, amplitude, period, and propagation delay can be provided without the transfer of waveform data.

The 7854's keystroke programming of local keyboard and remote Waveform Calculator allow user-designed waveform measurement routines—with all mainframe keystroke functions and operating modes remotely controlled via the GPIB.

The 2465A/2445A family offers a Counter/Timer/Trigger option for automatically measuring frequency, period, pulse width, and time between events. Also, by combining the GPIB and Digital Multimeter options, this system can efficiently perform both waveform and steady-state measurements. For a truly comprehensive measurement system, combine GPIB, Counter/Timer/Trigger, and DMM options.

Software development won't overwhelm your program if you use the built-in "Learn" mode of the 2465A/2445A-family GPIB option to generate detailed set-up instructions. With EZ-TEST software from Tektronix, your controller will do more for you while demanding less programming effort.

There are factory installed or retrofit options available for the 2230/2221/2220:

- GPIB (IEEE-488) Talker/Listener (instrument not fully programmable)
- RS-232 Talker/Listener (instrument not fully programmable)

Waveforms can be transferred each way on the bus. Only one of these options can be installed at the time of order. The scope is not programmable; however, single-sweep reset and some limited storage functions are programmable to enable "babysitting" applications. The 2230 also includes 26K of battery-backed memory with either the RS-232 or GPIB option for additional waveform storage (up to 52 waveform sets).

The 2220/2221 is available with GPIB or RS-232 options, but does not have battery-backed reference memory.

The compact 336 simultaneously displays real-time and digitally stored waveforms. An Auto mode allows "hands-off" operation in many applications.

The 10-MHz 5223 has a roll mode to provide a strip-chart-like view of signals at slow speed, the GPIB interface for I/O of stored waveforms, and control of several digital-storage functions.

KEY OSCILLOSCOPE SPECIFICATIONS AND FEATURES

You should choose an oscilloscope by matching both performance and features to measurement applications. Don't choose by performance alone, because when features make measurements easier, the result is likely to be more accurate measurements. Also, if your applications involve repetitive measurements, features that make the measurement faster will be cost effective.

The key oscilloscope specifications and features described below may help you make a decision.

Vertical-System Considerations

Because a faithful reproduction of the signal is necessary for measurement accuracy, and because very small signals must often be measured, the key specifications of the vertical system include bandwidth and sensitivity.

Depending on your applications, you might also want to consider oscilloscopes that display more than one signal at a time and those with differential or balanced inputs; these features are also described below.

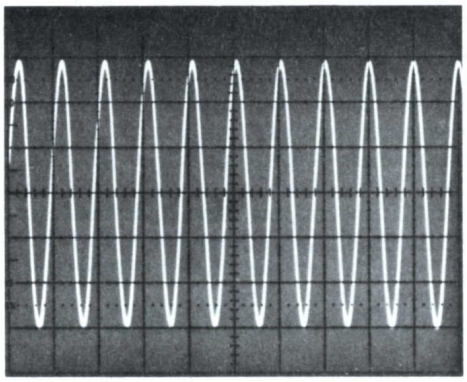
Bandwidth and Rise Time

Bandwidth is the range of frequencies that a scope can handle with less than a 3-dB loss in amplitude compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, the bandwidth specification is commonly the upper −3 dB frequency; the oscilloscope will display frequencies higher than the bandwidth, but at reduced amplitude. The following figures illustrate bandwidth specifications.

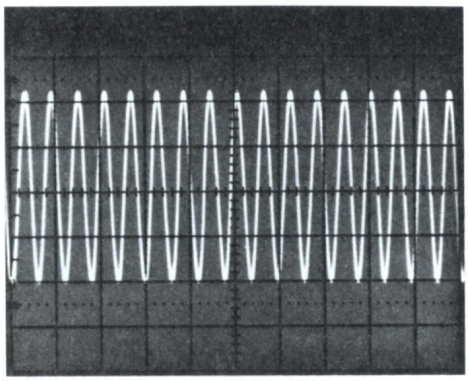
While a bandwidth specification is essential for the vertical system(s) of a scope, bandwidth is also sometimes specified for the horizontal system (which gives you a chance to evaluate performance in X-Y measurement applications) and for trigger systems (which permits you to determine the range of possible triggering signals).

The frequency response of most scopes is designed so that there is a constant that allows you to relate the bandwidth and rise time of the instrument with this approximation:

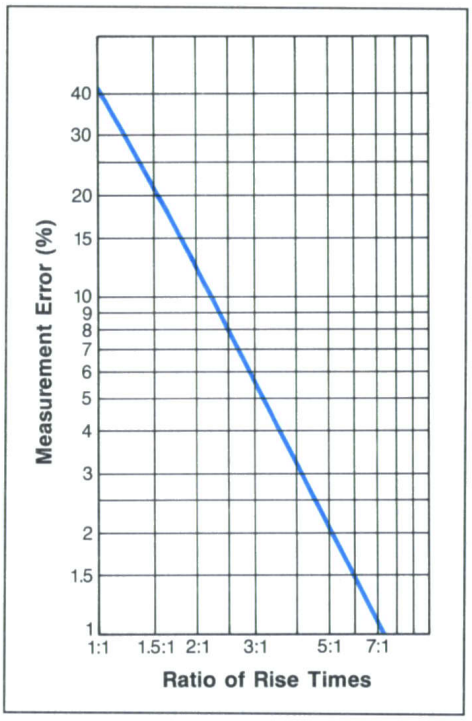
$$T_r = \frac{0.35}{BW}$$



0 dB: 6 div at 50 kHz.



−3 dB: 4.2 div at 100 MHz.



Given either specification (bandwidth or rise time), you can derive the other and determine if the instrument is suitable for your applications. The rule of thumb for timing measurements is to use an instrument with a rise time at least five times faster than the measurement you expect to make. A 5:1 ratio gives you a rise time measurement with ≤2% error. Other ratios and measurement errors are shown in the chart. Note that very accurate absolute rise-time measurements are not always a requirement. When you are comparing rise times, for instance, an instrument rise time equal to those being measured is often adequate.

Sensitivity

An oscilloscope sensitivity specification describes the input-signal level needed to produce a stated deflection of the electron beam within the CRT. Specifications typically are given in mV/cm or mV/div; with this spec, you can determine if small signals will be displayed with enough amplitude for you to make measurements quickly and accurately.

Note that, at a given state-of-the-art, sensitivity and bandwidth are trade-offs. The small amount of noise in even the best input circuit will mask very small signals. Raising the bandwidth also increases the noise picked up by the amplifiers, requiring a larger signal to create a clear display. As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make cleaner low-level measurements at moderate frequencies.

Although sensitivity specifications are most often associated with oscilloscope vertical channels, this specification can also be provided for horizontal systems and for trigger circuits.

Multiple Inputs

It is often quite useful to be able to view more than one input signal without disturbing the connections to your scope. Common applications include: comparisons of a device's input and output signals; checking signals against standards; making timing and/or phase measurements between events. These measurement requirements are usually satisfied by multitrace oscilloscopes that use electronic switching to alternately connect two or more input signals to a single deflection system. Multitrace scopes offer the lowest cost and the best comparison capabilities (because there is a single horizontal amplifier and one set of deflection plates). On the other hand, since a fast transient event might occur on one channel while the beam is tracing the other, dual-beam scopes like the Tektronix 7844 and 5113 are recommended for viewing single-shot phenomena. The 5113 has two independent vertical systems and a common horizontal system and can display up to eight waveforms in its Chop vertical operating mode. The dual-beam 7844 can be equipped with dual time-base plug-ins and then used to see a single event at different locations in the signal path, at two sweep rates if necessary.

Vertical-System Operating Modes

Multiple inputs, the Add vertical operating mode, and the ability to invert one channel let you cancel or reject any signal components equal in amplitude and phase that appear at both inputs. This ability provides a simple and accurate way to measure the difference between two signals, and to reject most unwanted signal components common to both inputs (such as power-supply hum).

Other vertical operating modes are Alternate (in which a complete waveform from one vertical channel is drawn before switching to draw the other), Chopped (in which the scope draws small parts of the waveforms while switching back and forth between the channels at a fixed rate), and Trigger View.

The Trigger View mode is useful any time you measure events dependent on an external triggering event.

Horizontal-System Considerations

The horizontal system of a modern oscilloscope provides a built-in sawtooth sweep generator. With this constant-speed horizontal deflection, measurements calibrated directly in units of time are possible. (As a consequence, the horizontal system of a scope is often called the time base.) This permits direct measurement of time between events, accurate time measurements on small portions of pulse trains, and even time measurements on single, nonrecurrent events.

Sweep Speeds

How fast a sweep speed do you need? One rule states that for frequency measurements at moderate frequencies, a sweep capable of displaying one cycle across the full horizontal scale is usually considered adequate. For example, one cycle of a 10-MHz signal can be displayed across 10 div with a 10-ns/div sweep. Don't apply this rule at ultra high frequencies, however, as scopes seldom have sweeps that fast.

Another approach emphasizes rise-time measurements. For maximum accuracy here, the scope should show the step signal (square wave, pulse, etc.) across most of the full vertical scale with the rising portion of the signal at nearly a 45° slope. For very fast rise times, this objective is rarely met because of compounding difficulties and the cost of providing extremely fast sweeps that are both linear and accurate.

Though neither rule can be applied at the very limits, fast sweep speeds are readily available: sweeps to 5 ns/div (500 ps/div magnified) in the 11000 Series and 2465A portables; to 200 ps/div with plug-in time bases for laboratory scopes; or to 10 ps/div with sampling plug-ins. (See Sampling Oscilloscopes in this reference section.)

Delayed-Sweep Measurements

Delayed-sweep scopes can offer you many measurement advantages. If the scope has two calibrated time bases and the Alternate horizontal operating mode (electronic switching of the trace between time bases), then convenient comparisons of the same signal at two different sweep speeds are possible.

If the second time base has an independent trigger, then jitter-free measurements on the delayed sweep are possible.

In every case, timing measurements with delayed sweep are easier to make, and in most cases, there is increased timing-measurement accuracy. Many plug-in time bases for laboratory scopes and most portable scopes offer delayed sweep. The 2400 Series offers dual delayed sweeps for even greater flexibility.

Accuracy

Accuracy in a scope's horizontal system is as important to timing measurements as vertical accuracy is to vertical measurements. The built-in time bases of the 11000-Series oscilloscopes provide timing accuracies to parts per million. Several of the 7000-Series plug-in time bases provide timing accuracies to ±1.5%, and the 2465A/2445A portable oscilloscopes provide timing accuracies to ±1%.

Probe Considerations

An oscilloscope will faithfully display the waveform(s) delivered to it. If the path between the scope and the device under test adds distortion or anomalies to the waveform, these will be displayed as well. A properly selected Tektronix probe will complete the total measurement system by establishing the critical path between the scope and the device under test.

Tek offers the industry's most complete selection of probes to answer your specific measurement needs. Refer to the Probes portion of the Accessories section.

Trigger-System Considerations

Besides sensitivity and bandwidth, the flexibility of the trigger system should be a consideration when choosing a scope. Some trigger-system features you might need for your measurement applications include:

- High- and low-frequency-reject coupling—for stable triggering on noisy signals.

- TV triggering—for automatic synchronization with video signals.
- Alternate triggering—for steady display of either signal with dual-channel scopes.
- Peak-to-peak autotriggering—for quick, convenient triggering with automatic level limits.
- Variable trigger holdoff—permits trigger-holdoff period to be varied to trigger on repetitive complex waveforms.
- Single sweep operation—for special applications such as capturing a transient pulse and for CRT photography.
- Auto Level Trigger—for automatic setting of the trigger level.

By combining logic-analyzer triggering capabilities with an oscilloscope, digital signals can be displayed in analog form for measurements of time and amplitude. The 7A42 Logic Triggered Vertical Amplifier extends the 7000-Series triggering into the arena of logic analysis. The 2400 Series offers options and accessories to provide delay-by-events triggering and Boolean-logic triggering.

CRT-System Considerations

CRT-system specifications will tell you how well the scope can display waveforms for direct viewing and for photography. A full complement of CRT-system controls contributes greatly to the instrument's ease of use. CRT-system controls to consider include:

Beam Finder—A single pushbutton that allows you to quickly locate any off-screen trace.

Autofocus—Autofocusing on both laboratory and portable scopes reduces the need for manual re-adjustments with changes in trace intensity; very useful when traces are displayed at different sweep rates, as in the Alternate horizontal operating mode.

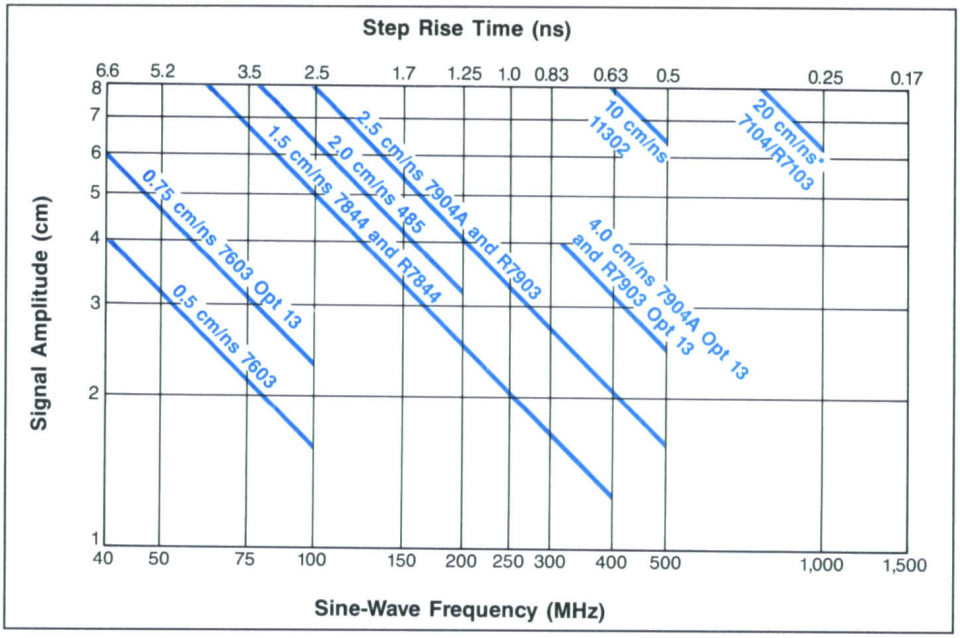
Auto Intensity—Maintains optimum trace intensity over a wide sweep-speed range.

External Z-Axis Input—Permits trace brightness modulation, makes some measurements easier by identifying events with an intensified zone on the trace.

WRITING RATE

Photographic writing rate is a measure of the scope/camera/film's capability to record high-speed signals.

Recording high-speed signals on film is dependent on at least three factors: the oscilloscope used, film characteristics, and the camera. For maximum writing-rate capability, the objective is to get as much light energy to the film surface as possible. Since each component affects photographic writing rate, the selection for top performance is important.



Amplitude vs speed and photographic writing rate comparison of 7000-Series mainframes using BE (P11) phosphors (Option 78), 20,000 ASA film, and the C-51 (f/1.2, 1:0.5) Camera.

BE (P11) phosphor has a different spectral output than GH (P31) phosphor and more closely matches the sensitivity spectrum of silver halide film types. While photographic writing rate is approximately two times the GH (P31) rate, the visual output luminance is writing rate is approximately two times the GH (P31) rate, the visual output luminance is approximately 15% of GH (P31) phosphor.

** The specified photographic writing rate indicated for the 7104/R7103, 11302, and 2467 are not directly comparable with that of the other mainframes shown. The microchannel-plate CRT of these scopes allows for the following relaxed photographic requirements: P31 phosphor, C-53 camera with f/1.9, 1:0.85 lens, and Polaroid Type 107 3,000 ASA film without film fogging.*

NOTE: A writing speed enhancer used to fog the film may increase the photographic writing speed. See the Accessories section.

A scope with a microchannel-plate (MCP) cathode-ray tube (CRT) has a visual writing rate that allows users to see clearly single-shot events and infrequent noise or signal anomalies. The 7104/R7103, 11302, and 2467 all contain a microchannel-plate CRT, which makes them ideal for research applications and digital design and troubleshooting. The microchannel plate, mounted just behind the front face of the CRT, multiplies the CRT beam current by a factor of 1000 to 10,000 to provide a trace many, many times brighter than is possible with a conventional CRT. With all Tektronix oscilloscopes with microchannel-plate CRTs, the user can view a single-shot transient at the maximum bandwidth and sweep rate of the oscilloscope in ambient light conditions, without the need of photographic aids. When photographing a single transient is desired for detailed study or documentation, the photography can be done simply, without the need for high-speed lenses/film or film-fogging techniques. (This is detailed in a footnote to the accompanying photographic writing rate graph.)

Writing Rate Comparison Graph

On the graph, signal amplitude on the vertical scale is shown against maximum sine-wave frequency (lower scale) and fastest rise time (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The ramp is assumed to be linear between the 10% and 90% points.

An application note describing photographic writing rate, including measurement procedures and applications, is available on request by referencing 42-W-5335-1.

Selecting a Phosphor

The catalog description of each oscilloscope indicates the phosphors normally supplied or available as options. While a special phosphor may be desirable for a specific measurement application, remember that each phosphor has its own color, persistence, burn resistance, etc. Improvements in one characteristic are usually at the expense of others. The Phosphor-Data chart provides comparisons.

COMPARATIVE CRT PHOSPHOR DATA

Phosphor*1 WTDS	JEDEC	Flourescence and Phosphor-escence	Relative Luminance*2	Relative Photographic Writing Speed*3	Decay	Relative Burn Resistance	Ordering Information Option*6
GJ	P1	Yellowish-green	50%	20%	Medium	Medium	Special order
WW	P4	White	50%	40%	Med-Short	Med-High	74
GM	P7	Blue*5	35%	75%	Long	Medium	76
BE	P11	Blue	15%	100%	Med-Short	Medium	78
GH	P31	Green	100%	50%	Med-Short	High	80
GR	P39	Yellowish-green	27%	NA*4	Long	Medium	40
GY	P43	Yellowish-green	40%	NA*4	Medium	Very High	Special order
GX	P44	Yellowish-green	68%	NA*4	Medium	High	
WB	P45	White	32%	NA*4	Medium	Very High	

*1 *Tektronix is adopting the Worldwide Phosphor Type Designation System (WTDS) as a replacement for the older JEDEC "P" number system referenced in this catalog. The chart lists the comparable WTDS designations for the most common "P" numbers.*

*2 *Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10-kV aluminized screens. GH (P31) as reference.*

*3 *BE (P11) as reference with Polaroid 612 or 106 film. Representative of 10-kV aluminized screens.*

*4 *Not available.*

*5 *Yellowish-green Phosphorescence.*

*6 *Some phosphor options may not be available on some products.*

Camera Considerations

Tektronix manufactures a variety of cameras designed for use with oscilloscopes. Two key parameters are the f-number of the lens and the magnification. These parameters affect the light-gathering capability of the camera. The chart utilizes a f/1.2 Tektronix C-51 Camera (f/1.9 Tektronix C-53 camera with the 7104 and 11302). More information on cameras is available in the Accessories section.

Film characteristics are also an important parameter. Generally, the higher the ASA rating of the film used, the higher the film sensitivity and thus, photographic writing rate. It should be recognized that film speed can vary with storage conditions and environmental factors. More information is available from film vendors.

Writing-Speed Enhancer

A writing-speed enhancer provides controlled fogging of the film to increase its sensitivity. The degree of writing-speed improvement is variable and is dependent on the film, camera, and scope combination used. More information is available in the Camera Reference section. A writing speed Application Note is also available by requesting 42-W-5335-1.

Digitizing Camera System

The DCS01 Digitizing Camera System easily and cost-effectively adds digitizing and signal-processing capability to analog oscilloscopes. The DCS01 bridges the gap between acquisition tools such as 2467, 7104, and 11302 and processing and analysis tools such as the PC. Now, digitize analog waveforms to 1 GHz and beyond, single shot, and analyze them immediately on an IBM PC/XT/AT or compatible.

DIGITAL FEATURES INCREASE OSCILLOSCOPE PERFORMANCE

The Tektronix 11301 and 11302 programmable analog scopes provide many of the measurement capabilities normally associated only with digitizing oscilloscopes. Both scopes make up to eight selected pulse-parameter measurements on the displayed signal automatically at a single request, without further operator intervention. The results of all eight measurements are displayed numerically on the screen, and are immediately available over the GPIB bus or RS-232C port.

The results of all measurements made with the instrument's built-in 500-MHz universal counter/timer—frequency, period, width, ratio, time A/B, and totalize are also immediately available over the GPIB or RS-232C. Display of template waveforms allows immediate visual comparison of live signals with previously defined waveform limits. A touch-screen numeric keypad permits the immediate scaling of scale factors to match transfer characteristics of devices such as accelerometers, pressure transducers, etc.

The 2445A/2465A Family offers a Counter/Timer/Trigger (CTT), which is included on the Special Editions, 2465A CT, DM, and DV, and optional for the standard scopes. This CTT option provides crystal-controlled time-base accuracy for several time-related measurements and is fully integrated with the operation of the scope and on-screen menus.

The DM 44 factory-installed option for 466 Storage Oscilloscopes allows you to read the delay time, time interval, or frequency right from an LED readout, with no calculation or interpolation required. The DM 44 also incorporates a digital volt/ohm meter and temperature-measurement capabilities. Combining digital capabilities within the oscilloscope system offers many advantages over separate test units, such as: increased accuracy, scope-controlled digital measurements, measuring convenience and confidence, easier and faster solutions to complex problems, a lower dollar investment, more bench space, and signal conditioning.

The 7B10, 7B15, 7B85, and 7B80 plug-ins for the 7000-Series oscilloscopes also provide Δtime measurements. With these plug-ins, the time-interval measurement can be shown on the screen using the 7000 Series CRT-readout capability.

STORAGE

When a conventional oscilloscope cannot capture an event and display it for your measurements because the signal is too slow, or too fast and infrequent, or when you need to compare events that happen at different times instead of simultaneously, consider a storage scope. These are obvious applications, but there are many other situations that also call for the unique advantages of storage. Storage can help you:

- Observe signal changes during circuit adjustments
- Compare new signals with a standard
- Increase the brightness of a dim, low-repetition-rate signal for normal viewing
- Reduce flicker or noise in a signal
- Babysit (unattended monitoring) for a transient event
- Provide pre/post trigger information

MODULAR NONSTORAGE OSCILLOSCOPES

Product	Bandwidth*2	Minimum Deflection Factor	Number of Traces	Maximum Sweep Rate	Price*3
7104/R7103	1 GHz	10 mV/div at BW	Up to 4	200 ps/div	$26,695/$27,275
7904A/R7903	500 MHz	10 mV/div at BW; 10 μV/div;1 mA/div	Up to 4	500 ps/div	$10,980/$9,840
11302*1	500 MHz	10 mV/div at BW 1 mV/div at 250 MHz	Up to 8	500 ps/div	$12,950
11301*1	400 MHz	10 mV/div at BW 1 mV/div at 250 MHz	Up to 8	500 ps/div	$8,500
7844/R7844	400 MHz	20 mV/div at BW 10 μV/div; 1 mA/div	Up to 4 Dual-Beam	1 ns/div	$16,595/$16,670
7603/R7603	100 MHz	5 mV/div at BW 10 μV/div; 1 mA/div	Up to 4	5 ns/div	$4,235/$4,805
5440/R5440	50 MHz	5 mV/div at BW 10 μV/div;0.5 mA/div	Up to 8	5 ns/div	$3,835/$3,910
5110/R5110	2 MHz	1 mV/div at BW 10 μV/div; 0.5 mA/div	Up to 8	100 ns/div	$2,095/$2,185

*1 *Programmable via GPIB or RS-232C; useful in Automated Test Applications.*
*2 *Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most 7000-series mainframes.*
*3 *Price does not include plug-ins.*

PORTABLE NONSTORAGE OSCILLOSCOPES

Product	Bandwidth	Minimum Deflection Factor	Dual Trace	Maximum Sweep Rate	Delayed Sweep	Price
2467*1	350 MHz	2 mV/div at BW	4 Channels	500 ps/div	X	$11,900
2465A*1						$5,500
2465A CT*1						$7,150
2465A DM*1						$8,400
2465A DV*1	350 MHz	2 mV/div at BW	4 Channels	500 ps/div	X	$9,200
2455A*1	250 MHz	2 mV/div at BW	4 Channels	1 ns/div	X	$5,350
2445A*1	150 MHz	2 mV/div at BW	4 Channels	1 ns/div	X	$3,590
2337	100 MHz	5 mV/div at BW	X	5 ns/div	X	$4,770
2336	100 MHz	5 mV/div at BW	X	5 ns/div	X	$4,270
2336YA	100 MHz	5 mV/div at BW	X	5 ns/div	X	$4,490
2335	100 MHz	5 mV/div at BW	X	5 ns/div	X	$3,940
2235	100 MHz	5 mV/div at BW; 2 mV/div	X	5 ns/div	X	$1,575
2235 Opt 01	100 MHz	5 mV/div at BW; 2 mV/div	X	5 ns/div	X	$2,195
2236	100 MHz	5 mV/div at BW 2 mV/div	X	5 ns/div	X	$2,795
2225	50 MHz	500 μV/div at 5 MHz; 5 mV/div at BW	X	5 ns/div	X	$995
2245	100 MHz	2 mV/div	4 Channels	2 ns/div	X	$1,775
2246	100 MHz	2 mV/div	4 Channels	2 ns/div	X	$2,400
305	5 MHz	5 mV/div at BW	X	100 ns/div		$3,060
221	5 MHz	5 mV/div at BW	X	100 ns/div		$2,715
213	1MHz	20 mV/div at BW 5 mV/div		400 ns/div		$3,300
212	500 kHz	10 mV/div at BW; 1 mV/div	X	1 μs/div		$2,095
SC 504*2	80 MHz	5 mV/div at BW	X	5 ns/div		$3,960
SC 502*2	15 MHz	5 mV/div at BW; 1 mV/div	X	20 ns/div		$2,840

*1 *Programmable via included or optional GPIB; useful in Automated Test Applications.*
*2 *The SC 502 and SC 504 are oscilloscopes that plug into a TM 500 or TM 5000 Mainframe for operation. See Modular Instruments section.*

- Capture fast signals that occur infrequently or only once
- Capture a complete display of a slowly occurring signal
- Enhance other recordkeeping techniques like photography

With the right Tektronix storage instrument, the capabilities you need are available, and the storage time can be anywhere from a few minutes to a practically unlimited length of time depending on your choice of instruments.

Bistable CRT Storage

The phosphor in a bistable CRT-storage scope has two stable states: written and unwritten. Once stored, this phosphor typically allows waveforms to be displayed for several hours, or until erased by the operator. Bistable storage is the easiest CRT-storage type to use. It is also the least expensive CRT-storage technology. It features bright, long-lasting displays, but in comparison with other storage technologies, bistable storage displays have less contrast.

The advantages of bistable storage make it particularly useful for mechanical measurements, signal comparisons, and data recording.

Variable-Persistence CRT Storage

If you don't need to store waveforms for hours at a time, variable-persistence CRT storage has advantages. The variable-persistence storage CRT has a storage mesh where the electron beam writes the input signal; thereafter, flood guns in the CRT illuminate the phosphor where the storage mesh permits.

CRT-storage controls vary the charge on the mesh, allowing you to control the contrast between the trace and the background and to fine tune how long the trace is stored.

The first capability provides easy viewing with high contrast between the dark background and bright waveforms. This type of storage provides the best displays when viewing traces with varying intensities, such as delaying and delayed sweeps, or traces with external z-axis (intensity) modulation.

Varying the persistence permits you to adjust the scope so that the entire waveform can be viewed, yet the stored trace will fade from view just as a new waveform is being stored. Also, you can view several traces before the first one fades from view. Then you can see signal-response variations as you make changes in a circuit.

Variable persistence can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Aberrations or jitter not common to all traces will not be stored or displayed. Low-repetition-rate, fast-rise-time signals that are not discernible on conventional CRTs can be easily viewed with this storage technology by allowing each repetition to build up the trace brightness.

Fast-Transfer CRT Storage

Fast-transfer storage scopes use a CRT with a special intermediate mesh target optimized for speed. This target captures the waveform and then transfers it to another mesh, one optimized for longer-term storage. As the name implies, the fast transfer-storage mode provides increased writing speed (see the next heading) for the 466 Portable Oscilloscope and the 7623A, 7633, and 7934 lab scopes.

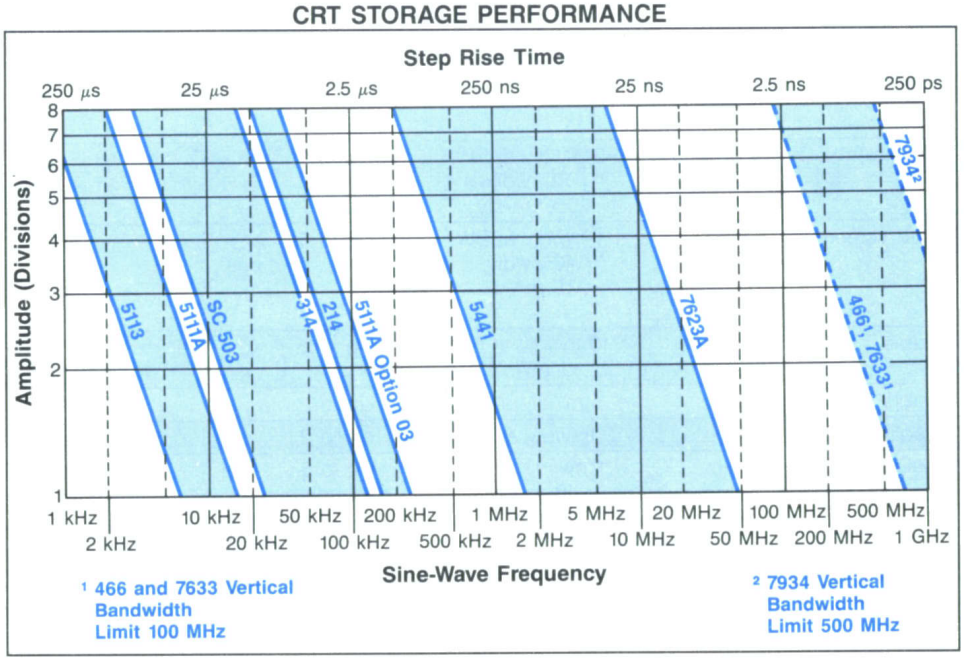
The second target can also be designed to offer bistable, variable persistence, or both modes in combination with the transfer mesh or by itself. In the 7623A, 7633, and 7934, this combination of capabilities provides unique multimode-storage instruments. Using front-panel controls, you can select the operating mode suited to your specific measurement situation.

Stored Writing Speed

For CRT-storage scopes, the storage-capability specification is the stored writing speed. This figure of merit is expressed in distance per unit of time. Often div/μs is more meaningful in terms of your measurements. However, because some scopes have nonstandard-sized graticules (i.e., other than 1-cm-square major divisions) cm/μs is useful only for comparisons.

The specification is dependent on the speed and amplitude of the input signal. If you know the pulse rise time or sine-wave frequency of the input signal and the amplitude of the waveform you want to display, you can use the table to determine which storage scope is recommended.

CRT STORAGE PERFORMANCE



Digital Storage

The fundamental difference between digital-storage scopes and CRT-storage scopes is that digital scopes quantize the captured waveform and CRT-storage scopes do not. Having quantized waveforms in a digital memory gives you measurement capabilities not possible with any other kind of oscilloscope.

With digital-storage scopes, you have the advantage of pretrigger viewing. In other words, you can look at a waveform both before and after the trigger event. Another feature is "babysitting"; available because the digital-storage scope's trigger can stop as well as start signal acquisition.

Other digital-storage scope advantages include signal-processing features such as averaging a number of samples of the input signal to reduce the effects of noise; performing calculations on the waveform parameters; or outputting the signal data over RS-232 or GPIB standard interfaces. Digital-storage scopes are typically easy to use and give you crisp, clear displays.

Because the data is stored in a digital memory, no fading or blooming of the trace on the CRT phosphor will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single-shot or low-repetition signals, or where the unique advantages of a digitized waveform may be the answer to your measurement needs.

Quantization Techniques

Within digital-storage scopes, there are two main techniques of quantizing signals

CRT-STORAGE OSCILLOSCOPES
In Order of Stored Writing Speed

Product	Stored Writing Speed	View Time	Type of Storage	Bandwidth*1	Maximum Sensitivity	Number of Traces	Delayed Sweep	Plug-In	Price
7934	8900 div/μs	30 s*3	Fast variable persistence	500 MHz	10 mV/div at BW	Up to 4	✓	✓	$13,620
	776 div/μs	30 min*4 minimum	Fast bistable						
	12 div/μs	30 s*3	Variable persistence						
	0.2 div/μs	30 min*4 minimum	Bistable						
466	3000 div/μs	15 s*3	Fast variable persistence	100 MHz	5 mV/div at BW	Up to 2	✓		$8,590
	3 div/μs	15 s*3	Variable persistence						
7633	2200 div/μs	30 s*3	Fast variable persistence	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	✓	✓	$9,950
	400 div/μs	30 min minimum	Fast bistable						
	3 div/μs	30 s*3	Variable persistence						
	0.2 div/μs	30 min minimum	Bistable						
7623A	150 div/μs	30 s*3	Fast variable persistence	100 MHz	5 mV/div at BW; 10 μVdiv; 1 mA/div	Up to 4	✓	✓	$7,895
	50 div/μs	20 min minimum	Fast bistable						
	0.5 div/μs	30 s*3	Variable persistence						
	0.003 div/μs	30 min minimum	Bistable						
5441	5 div/μs	1 hr	Variable persistence	50 MHz	5 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8	✓	✓	$6,070
5111A Opt 03	0.8 div/μs	10 hr	Bistable split screen	2 MHz	1 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8	✓	✓	$3,330
5111A	0.05 div/μs								$3,125
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW; 1 mV/div	Up to 2			$2,865
314	0.5 div/μs	4 hr	Bistable	10 MHz	5 mV/div at BW	Up to 2			$4,935
SC 503*2	0.08 div/μs	4 hr	Bistable	10 MHz	1mV/div at BW	Up to 2			$4,160
5113	0.02 div/μs	10 hr	Bistable split screen	2 MHz	1 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8 dual-beam	✓	✓	$4,375

*1 *Bandwidths are real time. Sampling plug-ins that extend bandwidth to 14 GHz are available for most 7000-series mainframes.*
*2 *The SC 503 is an oscilloscope that plugs into a TM 500/TM 5000 Mainframe for operation. See Modular Instruments section for details.*
*3 *View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.*
*4 *Save intensity at minimum.*

—and the technique has a direct effect on the applications of the instruments in that only one kind of digital-storage scope can capture single-shot signals.

The digital scopes that can capture single-shot signals use what is called "real-time sampling." Other digital-storage scopes use "equivalent-time sampling." There are two equivalent-time sampling methods and both require many repetitions of the input signal. In exchange for that requirement, you have the ability to measure signals more than ten times faster than can be captured with real-time sampling.

Digital-Storage-Scope Specifications

For digital-storage oscilloscopes that use real-time sampling, there is a useful storage-bandwidth specification. It expresses the highest frequency sine wave that can be captured in a single sweep and displayed so that you can make measurements. Both the digitizing rate (how often the scope takes samples) and the display reconstruction technique (how the scope displays what's in its memory) must be taken into account in the useful storage bandwidth. See the examples below.

For digital scopes using equivalent-time sampling, the specification is "equivalent-time bandwidth," the highest frequency signal that can be stored and displayed with less than 3-dB signal-amplitude loss. Besides analog specifications (common to all oscilloscopes), other specifications of interest to digital-scope users are:

Maximum Digitizing Rate—How often the instrument takes samples of the input signal.

Vertical Resolution (usually expressed in bits of resolution)—How finely the instrument can discriminate between signals much alike in voltage; for example, 8-bits of resolution is 0.391% when expressed as a percentage, and 10-bits is 0.098%.

Record Length or Horizontal Resolution—How many words of digital memory are used to store the captured waveform; if the signal is stored in 512 data words, the horizontal resolution is 1 in 512, or 0.195%.

The Basics of Choosing a DSO

You don't have to be an expert to choose the best digitizer for you, but you do need to understand how the digitizer design affects your measurements. The first and most important requirement is: Know your waveform, because choosing the right digitizer heavily depends on the types of waveforms you digitize. This will steer you to one type of digitizing method or another, depending on the following general rules:

1. For transients or nonrepetitive waveforms, real-time digitizing is required.
2. For repetitive waveforms, either real-time or equivalent-time digitizing can be used.
3. For repetitive waveforms above about 50 MHz, equivalent-time digitizing is usually most economical.

Of the above rules, the first is hard and fast: With transient or nonrepetitive events, there's no choice for a second look. Digitizing has to be done as the event occurs. This makes real-time digitizing the only choice for transients. The following information will help you choose the right digitizer for your application.

Bandwidth

Bandwidth is a familiar specification for analog instruments, and it applies to waveform digitizers as well. A digitizer's analog input circuitry has a bandwidth that has the same implications as bandwidth in any other instrument.

Digitizers have a kind of digital bandwidth too, determined by the relationship of sample rate to waveform frequency content. The critical frequency is called the Nyquist frequency, and is equal to half the sampling rate. Basically, the Nyquist frequency is the highest frequency component definable by sampling.

If you acquire a waveform having frequency components above the Nyquist frequency, those higher components will be aliased to appear below the Nyquist frequency as low-frequency components. This has minimal impact as long as the major frequency components of the waveform already exist below the Nyquist frequency. In extreme cases, however, loss of significant high-frequency content through aliasing can cause stretching of transitions and rounding of waveform corners. The result is similar to exceeding the bandwidth specification of an analog instrument, except high frequencies reappear as low frequencies, instead of merely being attenuated.

What happens if you acquire a sinusoid at or near the Nyquist frequency? You'll only get two samples per cycle of the sinusoid. While that may be sufficient to define it in the frequency-domain, two samples per cycle is woefully short of providing usable time-domain resolution. What is needed for correct digitizing is substantial oversampling. The Nyquist frequency needs to exceed the bandwidth of the instrument to produce multiple samples per cycle. For most digitizers, Nyquist frequency is specified in terms of maximum sample rate or time between points. These relationships can be expressed by: FN = Sample Rate/2 or ½ the Sample Interval.

Kinds of DSOs

Now that we've looked at the relationship between bandwidth and maximum sample rate, you can pick the kind of digitizing you need. There are really only two kinds—real-time and equivalent-time. Figures 1 and 2 illustrate the difference.

Real-time digitizing for everything would be ideal, but there are limits. Real-time digitizing of a high-frequency waveform requires very fast sampling and conversion rates along with very fast memory for storing the data. For example, to capture just two samples per cycle on a 100-MHz sine wave requires a sample rate of 5 nanoseconds/point. That means leading-edge, state-of-the-art digitizing and memory technology. This need for speed usually results in a speed/resolution trade-off, the major disadvantage of continuous real-time digitizing.

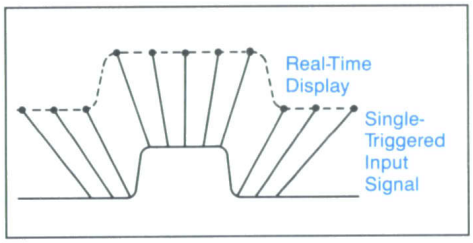


Figure 1. In real-time sampling, samples are taken one after the other, in order, from the beginning of signal acquisition to its end.

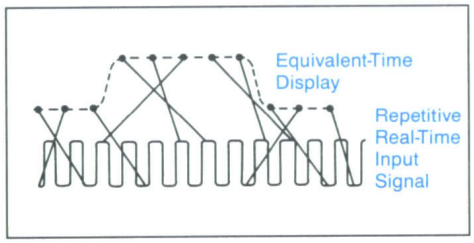


Figure 2. Equivalent-time digitizing can use either random or sequential sampling (random is shown in the illustration). In both cases, a few samples are taken from each of numerous acquisitions of a waveform and then assembled into a representation of one waveform (the dotted line).

The exception in real-time digitizing is the scan-conversion technique. Scan conversion, however, is not really continuous. A scan converter takes a snapshot of the waveform and then spends a block of time doing the conversion of all samples as a batch, rather than continuously digitizing on a sample-by-sample basis like other real-time digitizers.

There's a way out of the dilemma. If the waveform is repetitive, you don't have to capture it in real time. A typically lower-cost approach for repetitive waveforms is using equivalent-time methods to achieve higher effective sampling rates, as high as 100 gigahertz or more in some cases.

The equivalent-time sampling technique limitation is that it can only be used to its full range on repetitive waveforms. For single-shot acquisitions, the bandwidth is much lower since the digitizer must take data in real time. That means the sample rate is the actual—not the effective—real-time sample rate of the equivalent-time digitizer. As a result, the single-shot digital bandwidth will be one-half the actual sample rate. Newer digitizers provide a different solution to this dilemma—combining real-time and equivalent-time digitizing in one instrument. This extends the effective bandwidth of the digitizers.

Vertical Resolution

How fine and how deep do you need to look at the waveform you captured? Vertical, or amplitude, resolution for digitally stored waveforms is determined by the number of bits used in digitizing. An 8-bit digitizer, for example, resolves amplitude to 1 in 256 distinct levels. So if the vertical (or voltage) range of the digitizer is one volt, 3.9 millivolts can be resolved (1 volt/2^8). For more resolution, more bits are required, and a 10-bit (1 out of 1024) or 12-bit (1 out of 4096) digitizer might be specified. The accompanying table will help you relate bits of resolution to other methods of expressing resolving power.

BITS	PERCENTAGE	PPM
1	50.0%	500,000
2	25.0%	250,000
3	12.5%	125,000
4	6.15%	62,500
5	3.125%	31,250
6	1.563%	15,625
7	0.781%	7,812
8	0.391%	3,906
9	0.195%	1,953
10	0.098%	977
11	0.049%	488
12	0.024%	244

As always, there are trade-offs; vertical resolution is no exception. Generally the higher the digitizing rate, the fewer bits that can be used.

Horizontal, or Time, Resolution

Horizontal, or time, resolution is the time interval between samples on the acquired waveform. This is given by the inverse of the sample rate and can also be computed by dividing record duration by the number of samples in the record.

It's important to specify a resolution adequate for definition of waveform detail. To make rise-time measurements, for example, the sample rate has to be fast enough to place more than just a few samples on the pulse's transition. The more samples on the rise, the better its definition and the greater the measurement resolution. But this depends on adequate vertical resolution too. Defining rise time depends as much on being able to find the 10% and 90% amplitudes of the pulse with the desired resolution.

For time resolution, there are two things to consider—record length and sampling rate. Record length is the number of waveform points or samples acquired and is usually a power-of-two number: 128, 256, 512, 1024, etc., points. Some digitizers have a fixed record length and the sample rate is varied by the horizontal time-base setting. For example, for a digitizer with a 512-point record length and a time-base setting of 50 microseconds/division for 10 horizontal divisions, the sample interval or time resolution is $(10 \times 50 \times 10^{-6})/511$, or 0.978 microseconds. In other digitizers, both record length and sample rate are directly selectable, giving you more acquisition flexibility.

It is important to match record length, sample rate, and record-duration capabilities to your acquisition needs. A transient having a fast rise and slow exponential decay requires more record length than short duration pulses or most types of repetitive waveforms. You need a fast sample rate for resolution on the fast rise and a long record length in order to contain the slower portion of the record as well.

Built-In Waveform Processing

Whatever the method of sampling and digitizing, the point is the same: Express the waveform as a set of discrete values that can be stored in digital memory. Then, signal-processing techniques can be used to extract the required information from the digitized data. The ability to obtain waveform measurements at a push of a button is a significant step toward greater measurement productivity. No more counting screen divisions and multiplying by scale factors. And, no matter who pushes a button to initiate a measurement, the measurement is done the same way every time by the instrument.

Productivity Through Programmability

With programmable controls, digitizer set-ups for various measurement configurations can be stored, then recalled as needed. Productivity and repeatability are increased since the system can execute standard setups faster and more accurately than a human operator.

Instrument control and waveform-data transfer over the GPIB or RS-232C interfaces opens another realm of measurement possibilities. Highly complex measurement sequences can be reduced to programs that automatically set up the instruments, gather the data, process the data, and output the results. Now, the amount of data storage and processing that can be done is essentially limited only by the computer and peripheral power you have available.

The Features

Besides built-in measurement functions and programmability, there are many other features to choose from—and more are being added with each new instrument that is introduced. The following list should suggest some that might determine which digitizer best fits your needs: Multiple waveform storage, oscilloscope-type display, cursor measurements, averaging, peak detection, settings storage, programmable set-ups, built-in signal processing, envelope mode, pre- and post-triggering, save-on-delta, sample-rate switching, analog real-time capability, and roll mode.

SAMPLING OSCILLOSCOPES

Sampling is a powerful technique for examining very fast repetitive signals. In principle, sampling is similar to the use of stroboscopic light to study fast mechanical motion. Progressive samples of different portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown (all seemingly at one time) on the screen of a CRT. The display produced is a replica of the sampled waveforms.

Sampling scopes are capable of resolving events that occur in less than 30 ps on an "equivalent" time base of less than 20 ps/div with less than 5 mV of peak amplitude.

If your measurement needs require equivalent bandwidths to 14 GHz or sweeps to 10 ps/div, consider the sampling plug-ins described in the Sampling Systems section.

TEKTRONIX DIGITIZER COMPARISON*1

Features	5223 Digital Scope	336 Digital Scope	2230/2221/2220 Digital Scope	11401/11402 Digitizing Scope	7854 Waveform Processing Scope	7250 Digitizing Oscilloscope	2430A/2430M Digital Scopes
Digitizing Technique	Successive approx	Successive approx	Dual stage flash Conversion	Dual stage flash conversion	Successive approx	Scan Conversion	CCD
Maximum Sample Rate	1 MS/s (1 μs/point)	1 MS/s (1 μs/point)	20 MS/s	20 MS/s	500 KS/s (2 μs/point)	1000 GS/s (1 ps/point)	100 MS/s
Vertical Amplifier Analog Bandwidth	10 MHz	50 MHz	100 MHz (2230) 60 MHz (2220, 2221)	500 MHz (11401) 1 GHz (11402)	400 MHz/real (14 GHz/samp.)	6 GHz	150 MHz
Vertical Resolution	8-bits	8-bits	8-bits	10-bits; 14-bits with averaging	10-bits	11-bits	8-bits
Record Length (Points)	254 to 1016	1024 per channel	2048 dual 4096 single	512 to 10,240	128 to 1024	512	1024
Input Channels	Up to 4 chopped	2 chopped	2 chopped	Up to 12 (Up to 8 displayed)	Up to 4 chopped	1	2 simultaneous
Independent Time Bases	1 plus delaying	1 plus delaying	1 plus delaying (2230); 1 (2220, 2221)	1 main and 1 window	1 delaying	1	1 plus delaying
Maximum Sweep Speed	200 ns/div (20 ns in X10)	100 ns/div (10 ns in X10)	50 ns/div (5 ns in X10)	500 ps/div	500 ps/div (20 ps/div) Sampling	50 ps/div	5 ns/div
Pretrigger	Yes, with 5B25N	pre, mid, post	Yes	Yes		No	Yes
Posttrigger	Yes, w/delaying	Yes	Yes	Yes	Yes, w/delaying	Yes	Yes
Waveform Storage Registers	2 to 4	2 plus 16 opt	3 plus 26 opt (2230); 1 (2220, 2221)	64K points 102K points (opt)	2 to 16 (5 to 40 opt)	15 @512 points	6
Waveform Processing		averaging enveloping CH 1±CH 2 CH 1×CH 2, RMS, mean, p-p	averaging (2230,2221) smoothing enveloping (2230,2221)	waveform functions pulse parameters	averaging parameters keystroke programming	averaging enveloping filtering smoothing waveform measurements	averaging envelope save on delta multiply, add, waveform measurements
Waveform Data Output Format	ASCII or binary	Binary	ASCII, binary, hex	ASCII or binary	ASCII	ASCII, binary	ASCII or binary
Prices begin at	$6,800	$5,470	$4,995/3,995/2,995	$13,000/15,500	$15,275	$99,995	$8,900/18,400

*1 *For applications not requiring programmability, see the 5D10 Waveform Digitizer in the 5000-Series Instrument section.*

TEKTRONIX DIGITIZER COMPARISON*1

Features	RTD 710 Waveform Digitizer	7612D Waveform Digitizer	7912HB Digitizer	DCS01 Camera System w/7104
Digitizing Technique	Dual-stage flash conversion	EBS*2 flash conversion	Scan conversion	Scan conversion
Maximum Sample Rate	200 MS/s (5 ns/point)	200 MS/s (5 ns/point)	100 GS/s (10 ps/point)	250 GS/s (4 ps/point)
Vertical Amplifier Analog Bandwidth	100 MHz	80 MHz	750 MHz (7A29P)	1 GHz (7A29)
Vertical Resolution	10 bits	8 bits	9 bits	12 bits/rep 9 bits/single shot
Record Length (Points)	1024 to 65,536	256 to 2048 per channel	512	512
Input Channels	2	2	1	1
Independent Time Bases	1 plus delaying	2	1	1
Maximum Sweep Speed	N/A	N/A	500 ps/div	200 ps/div
Pretrigger	Yes	Yes	Delay line only	No
Posttrigger	Yes	Yes	No	No
Waveform Storage Registers	1 to 64	2 to 16	1	26 (PC dependent)
Waveform Processing	averaging, enveloping		averaging	waveform functions; pulse parameters; save on delta
Waveform Data Output Format	Binary	Binary	Binary	ASCII or binary
Prices begin at	$20,950	$29,475	$30,025	$5,500

*1 *For applications not requiring programmability, see the 5D10 Waveform Digitizer in the 5000-Series Instrument section.*
*2 *Electron bombarded Silicon.*

Technical Assistance Services

- **Installation Assistance**
- **Familiarization Training**
- **Custom Training**
- **Problem Definition and Debugging Assistance**
- **Interfacing Assistance**
- **Applications Assistance**

When Your Systems Development Program Calls for Informed, On-Site Assistance, Tektronix Can Keep You in Touch with Some of the Best in the World.

With Tek Application Engineers, you enjoy a resource that you can draw on to help you derive maximum benefit from Tektronix system components.

When you need assistance to supplement your own resources, Tek can arrange the consultive services of an Application Engineer skilled in meeting your needs.

Not only are our AEs skilled professionals in their own right, they are backed by the resources and collective experience of Tektronix—itself an experienced user of automated test and measurement systems.

Tektronix AE Consultation is Intended Specifically for Optimizing the Operation of Tek Instruments and Software.

We suggest that customers may first want to avail themselves of Tek's excellent documentation and regular customer training programs prior to requesting our Technical Assistance Services. Typical consulting services include:

Installation Assistance
This may include pre-installation counseling, assistance in installing hardware or software, and installation validation.

Familiarization Training
This usually takes the form of a brief introduction, to individuals or groups, or hardware basics, system interaction, and software utilization. Other training modules may present specific operational aspects of a product.

Custom Training
You may require that unique training modules be designed and presented to meet an unusual application, environmental or personnel need.

Problem Definition and Debugging Assistance
Application Engineers can help you trace and debug problems within a hardware/software system.

Interfacing Assistance
We can assist you with unusual interfacing challenges requiring intimate knowledge of Tek hardware and software.

Applications Assistance
You can obtain expert consultation in signal acquisition, in specific test and measurement tasks, in integrating Tek hardware and software within an existing process, and in other application-specific areas.

ORDERING INFORMATION

Technical Assistance Services—
1 hour increments.
Order 068-9080-00 **$125/hr**

If you'd like to know more about these Tek consulting services, please call your Tektronix Sales Engineer.

Custom Measurement Systems

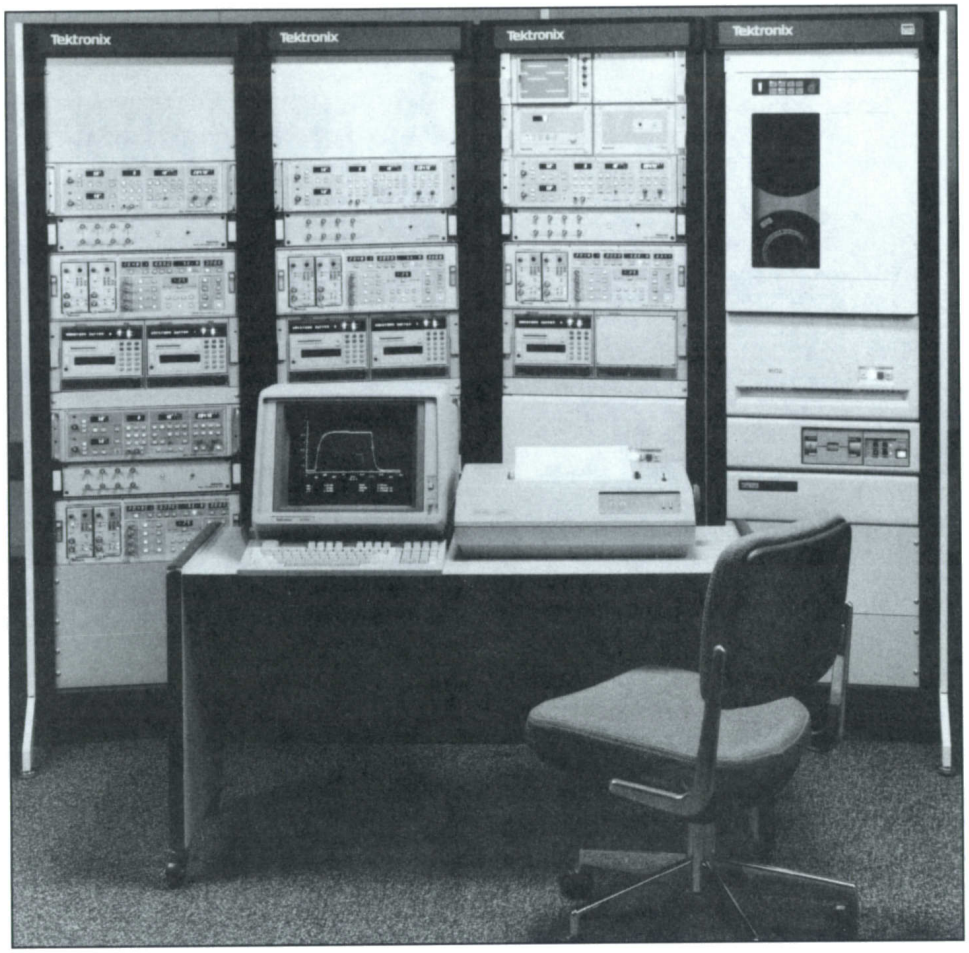
- Complete Custom Systems
- Customized Measurement Packages
- Customized System Products
- Custom Support
- System Installations
- Specialized Products

When we say we'll custom configure a system that puts you in charge of your automated measurements, we mean just that.

From one-of-a-kind complete systems to modifications of selected digitizing products, we can tailor a package based upon your present and future needs, your budget, and the desired degree of continuity with your current hardware and software components and requirements.

You bring to the table your unique understanding of your requirements; we bring our unique expertise in instrument-systems integration.

We're TEK's Custom Systems team—a small, quasi-independent cadre of hardware, software, and systems engineers. We work with entrepreneurial decisiveness and speed: your project gets the attention it deserves. At the same time, we call on the vast resources of Tektronix—the world's leading manufacturer of test-and-measurement systems instrumentation.



OUR SPECIALTIES

We specialize in high-speed acquisition, data logging, and diagnostic test systems—multichannel or not—for research, design, and engineering; time-domain parametric measurement systems; and flexible, reconfigurable automated test systems for low-run manufacturing environments.

Because it's your system, the choice of logical alternatives is yours whenever possible.

Together we evaluate hardware, custom software, including refined application and diagnostic programs and the drivers to run them, custom cabinetry or racks, and non-Tek components if we agree they'll do a better job. Together, we'll define performance standards, and resolve other contract terms and conditions.

Then we'll design your system to meet your requirements. We'll assemble it and run a complete check-out *before* installing it on your site. We'll provide diagnostic programs, documentation, test procedures—all customized for your particular system.

By blending the best of technologies, we aim to build systems that do in minutes tasks that may now take days.

Our systems combine Tek's leadership in waveform-acquisition instruments with automated stimulus and acquisition measurement capability. All are computer-integrated and directed by powerful signal-processing software.

As a result, your projects can get finished more quickly, improving the productivity of your engineering team and the cost effectiveness of your system investment, while lowering project costs.

To ease your selection process, you can contract for any of three tiers of Tek custom-system services.

CUSTOMIZED MEASUREMENT PACKAGES

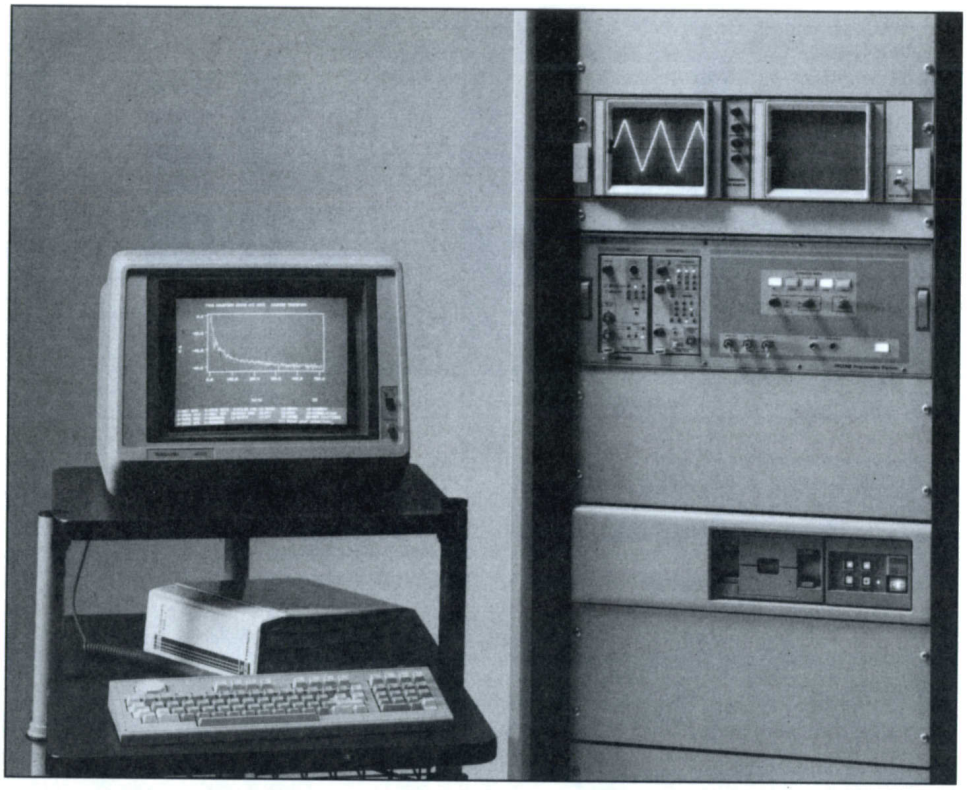
Customized Measurement Packages are modifications to existing preconfigured systems. Each offers powerful capability in a cost-effective benchtop size. Signal-acquisition units span bandwidths of up to 750 MHz real time and up to 14 GHz with sampling plug-ins.

MODIFIED PRODUCTS

Modified Products include the customization of selected digitizers, as well as the "system glue" (specialized internal interfaces, etc.) required to hold the system together.

These off-the-shelf custom items for your system needs include:

- Additional serial I/O drivers for your communications/printing needs. Up to 8 instrument channels and up to 4 peripheral ports may be supported.
- Special disk drivers for RL02 disk pack drives for TEK SPS BASIC V02.
- GPIB program decoder plug-in that enhances the 7854 oscilloscope by interfacing to programmable vertical and time-base settings with selected plug-ins.
- High-speed buffer memories for DMA collection of long-record data streams.



- A high-bandwidth modification (750 MHz) of the 7912AD digitizer.
- Auto-calibration MUX controller and stimulus generator.
- High-speed data-output modification for the 390AD digitizer.
- Others per your request.

CUSTOM SYSTEMS

Custom Systems offer single-shot or repetitive-measurement capability and control of up to 56 GPIB instruments per controller, fully configurable to your specifications. Included are full warranties, installation, and other product-support services.

While we provide the core system package, specialized drivers, and software operating system after consultation with your software engineers and operating personnel, it is generally more cost effective for you to provide your own applications software. This better prepares users to do routine modifications and updating, and gives you the local expertise you need to make the best use of your system investments.

Tek minicomputer systems built around the DEC Micro/PDP-11 handle larger amounts of data and offer considerable flexibility in peripheral selection, processing power and speed, software modularity, and extended memory.

SOFTWARE

Tektronix minicomputer systems are operated with TEK SPS BASIC, a powerful general-purpose programming language that offers convenient control of instruments to acquire, process, store, and display waveform data with ease. See the GPIB section in the front of this catalog for more details.

The Custom-Systems Domain

The following list samples the breadth of activity typically performed by Tek's digitizer-based Custom Operations Group.

CUSTOM SYSTEMS

These include large, multichannel test-and-research systems incorporating a wide variety of Tek digitizers and acquisition instruments, both for major military installations and defense contractors, and for a variety of commercial test applications such as fiber optic research and disk testing.

MODIFIED STANDARD SYSTEMS

Modified Standard Systems include laboratory and mobile systems for EMP susceptibility studies, plus several modified standard systems for energy research, for major governmental and private research labs.

CUSTOM INSTRUMENTS

Include plug-in interface for programmable plug-in control in the Tek 7854, plus custom drivers for large customer-designed and assembled systems.

CUSTOMIZED SYSTEMS

Include modified Tek 7912ADs for higher bandwidth, modified Tek digitizers and acquisition instruments for MIL-ATE applications.

Custom Support

Once we've completed installation, our support continues for as long as you request.

Product warranties, stipulated for each system instrument, cover all hardware and software. Additionally, our System Warranty covers installation and service at your site for 90 days from the date of your acceptance, or 120 days from the shipment.

On top of that, maintenance contracts are usually available for both systems and components. At the expiration of the warranty period, you can contract for Tektronix to serve as the single source for system maintenance. Such contracts can be arranged for any length of time through your local Tektronix service site.

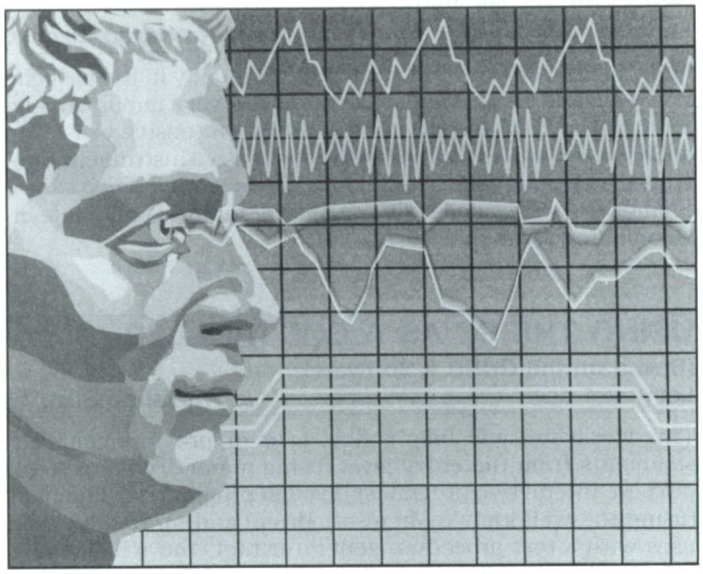
Pre-installation consultation, operator and product-maintenance training may also be arranged, at the Tek home office and sales offices, or on-site. When you need additional support down the road, our applications engineering and product service staffs can help keep your systems tuned and your people informed.

Finally, documentation is thorough, clear and complete, in the Tektronix tradition. Regular updates and a user's exchange program are only two of the many ways Tek stays in touch with its system owners.

When it comes to your custom system requirements, we know the right questions to ask as well as the right answers; let's begin discussing your special needs now.

Your local Tektronix representative can put you in touch with the right people—the people who help put you in charge of your automated measurements. Let's start working together today.

TRAINING GETS USERS UP TO SPEED, FAST



An Investment—Tektronix workshops develop your skills and are one of the best methods to realize more effective use of your equipment.

New Perspective on Applications—Professional instructors are available to help you examine and evaluate your application problems during laboratory sessions.

New Methods of Making Measurements—Our workshops are designed to aid in developing new ideas through comprehensive discussion and laboratory exercises.

Tektronix offers formal classes and self-study aids. See the following paragraphs for general information on our workshops, then ask your Tektronix Sales Engineer for details about Customer Training.

Test and Measurement—Tektronix instruments and programmable instrument systems represent the upper limits of productivity potential. Tektronix has designed workshops to help enhance your understanding of the capabilities of your equipment.

Measurement workshops are a natural complement to the Tektronix commitment to help you achieve optimum utilization of your equipment. Our commitment begins with engineering excellence and continues through high-quality training that will help you develop new and more productive applications.

These fast-paced workshops, conducted at key locations throughout the U.S., combine classroom lectures with supervised, hands-on laboratory sessions. You will spend at least 60% of your time in labs, so you can *learn by doing.* You will receive workbooks containing detailed course notes and lab exercises in all Tektronix workshops.

For your convenience, Tektronix also offers private workshops conducted at your company.

WORKSHOPS

WAVEFORM MEASUREMENTS

(Based on the 11401/11402)
Length: 1 day **Workshop Size:** 16

After completing this one-day workshop, you will be able to easily make standard and custom measurements using Tek 11400 Series digital oscilloscopes. The training workshop consists of six training modules and six intensive workshop labs.

ADVANCED WAVEFORM MEASUREMENTS

(Based on the 11401/11402)
Length: 2 days **Workshop Size:** 16

This two-day workshop includes the six modules of the standard Tek 11401/11402 workshop, plus five more modules and labs: time A-B measurements using triggers, waveform functions, waveform arithmetic, GPIB, RS232-C, and Utility Software for the PC (Personal Computer).

WAVEFORM MEASUREMENTS AND ANALYSIS (Based on the 11301/11302)

Length: 1 day **Workshop Size:** 16

This comprehensive one-day workshop takes you from using the built-in automatic measurements, to counter/timer measurements and enhanced measurements accuracy on the Tek 11300 Series instruments. The workshop includes six training modules and six comprehensive labs.

ADVANCED WAVEFORM MEASUREMENTS AND ANALYSIS (Based on the 11301/11302)

Length: 2 days **Workshop Size:** 16

This two-day workshop includes modules taught in the standard Tek 11301/11302 workshop, plus additional modules that cover the advanced capabilities featured on the 11300 Series instruments including setting up the GPIB interface.

XYZ'S OF USING A SCOPE

(Based on the 2200 Series)
Length: 1 day **Workshop Size:** 16

This workshop provides an introduction to the oscilloscope for the new user. Basic operation is explained and measurement techniques are described and performed in lab exercises. This is an intensive one-day workshop that will bring first-time users of oscilloscopes up to a high level of competency.

PARAMETRIC MEASUREMENTS

(Based on the 2465A)
Length: 1 day **Workshop Size:** 16

This fast-paced workshop covers parametric measurements typically made with an oscilloscope. The workshop gives the average oscilloscope user a high degree of expertise in making accurate parametric measurements that fully utilize the capabilities of an oscilloscope.

ADVANCED PARAMETRIC MEASUREMENTS

(Based on the 2465A DV)
Length: 1 day **Workshop Size:** 16

This fast-paced workshop teaches advanced applications using the enhanced measurement options available on the Tek 2465A. Advanced parametric measurements are made in "hands-on" labs utilizing special features of the Digital Multimeter, TV/Video Trigger, Counter/Timer/Trigger, and Word Recognizer.

DIGITAL STORAGE MEASUREMENTS

(Based on the 2230)
Length: 1 day **Workshop Size:** 16

Digital storage oscilloscopes offer new and exciting measurement capabilities. Digital storage techniques save time, increase productivity, and signals can be acquired for direct viewing or stored for later analysis. This workshop covers various techniques of measuring signal parameters. Also covered are the basic concepts of digital acquisition and storage. These are taught using the Tek 2230 Digital Storage Oscilloscope.

ADVANCED DIGITAL STORAGE MEASUREMENTS (Based on the 2430A)

Length: 2 days **Workshop Size:** 16

Many measurements that are difficult or impossible with an analog oscilloscope are made faster, simpler, and more accurately with a digital oscilloscope. This workshop covers several types of measurements and the techniques behind them. You will see how they can immediately increase your through-put. The Tek 2430A is the Digital Oscilloscope used.

WAVEFORM PROCESSING (Based on the 7854)

Length: 2 days **Workshop Size:** 16

This fast-paced two-day workshop is designed to increase your proficiency with the Tektronix 7854 Waveform Processing Oscilloscope and to satisfy your application/measurement needs. The workshop is oriented toward technically competent oscilloscope users with wide variances in background and experience. All 94 commands/operators on the front panel and remote keyboard are covered.

ADVANCED WAVEFORM PROCESSING

(Based on Tek SPS Basic language)
Length: 4 days **Workshop Size:** 10

This comprehensive workshop teaches you how to effectively implement programming solutions to waveform digitizing and processing problems using Tek SPS Basic. Also covered is controlling and transferring data with the 7912HB and 7612D Digitizers. This workshop is oriented towards those with a fundamental knowledge of computers, computer programming, and an understanding of oscilloscope operation/applications.

USING AN INSTRUMENT CONTROLLER

(Based on the Tek 4041)
Length: 1 day **Workshop Size:** 16

Many measurements that were done manually in the past can now be made with automated systems. A very important element of the system is the controller. This intensive workshop shows you how to quickly generate extensive instrument Controller programs using the Tek 4041. The workshop gives you "hands-on" experience with an automated programmable instrument system.

USING THE PC AS A CONTROLLER

(Based on the GURU II Software)
Length: 1 day **Workshop Size:** 16

This workshop will take a new user of programmable instruments from the entry level (using menu-driven, general purpose interactive programs) through program development (using the well-known Microsoft Basic) and on to advanced uses with a test procedure generator tool. You will learn to effectively use a PC and the Tek GPIB Users Resource Utility (GURU II) to control GPIB programmable instruments. Software examples and application reference information are provided.

SAMPLING AND TDR MEASUREMENTS

Length: 1 day **Workshop Size:** 16

This workshop introduces the concepts of Analog Sampling and Time Domain Reflectometry. The workshop discusses measurement challenges and provides valuable "hands-on" experience.

ABC'S OF USING A PROBE

(Based on Voltage/Current/Active Probes)
Length: 1 day **Workshop Size:** 16

This workshop is designed to teach the basics of signal acquisition. Types of probes available, how probes affect measurements, and how to select the appropriate probe for your application are discussed in this workshop. Participants make various measurements using the three families of probes in comprehensive lab situations.

SELF-STUDY COURSES

WAVEFORM MEASUREMENTS

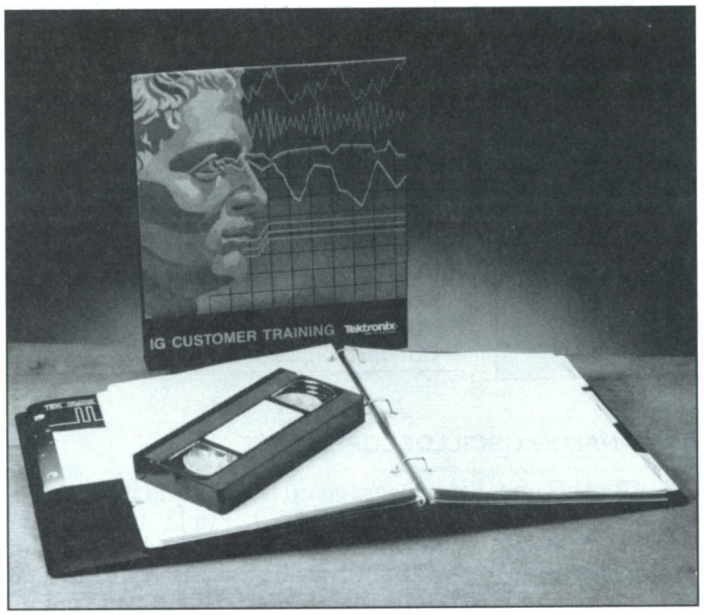
(Based on the 11401/11402)
Self Study 6 Modules with 6 labs 1 Video Tape

After completing this self-study package, you will be able to easily make standard and custom measurements using the 11401/11402. This self-study program consists of six modules and six labs (with answers), an index, and a 27-minute video tape on operation of 11400 Series instruments.

ADVANCED WAVEFORM MEASUREMENTS

(Based on the 11401/11402)
Self Study 11 Modules with 11 labs 1 Video Tape

This self-study package includes the six modules/labs of the standard 11401/11402 training, plus five more modules and labs. Added coverage includes time A-B measurements using triggers, waveform functions, waveform arithmetic, GPIB, RS232-C, and Utility Software for a PC.



WAVEFORM MEASUREMENTS AND ANALYSIS (Based on the 11301/11302)

Self Study 6 Modules with 6 labs 1 Video Tape

This comprehensive self-study package takes you from using the built-in automatic measurements on the 11300 Series instruments to counter/timer measurements and enhanced measurement accuracy. It includes six modules and six labs (with answers) and index. A video tape on the operation of the instrument is also included.

ADVANCED WAVEFORM MEASUREMENTS AND ANALYSIS (Based on 11301/11302)

Self Study 10 Modules with 10 labs 1 Video Tape

This self-study package includes the six modules of the standard 11301/11302 training program and four modules/labs covering the advanced capabilities featured on the 11300 Series instruments, including setting up the GPIB Interface.

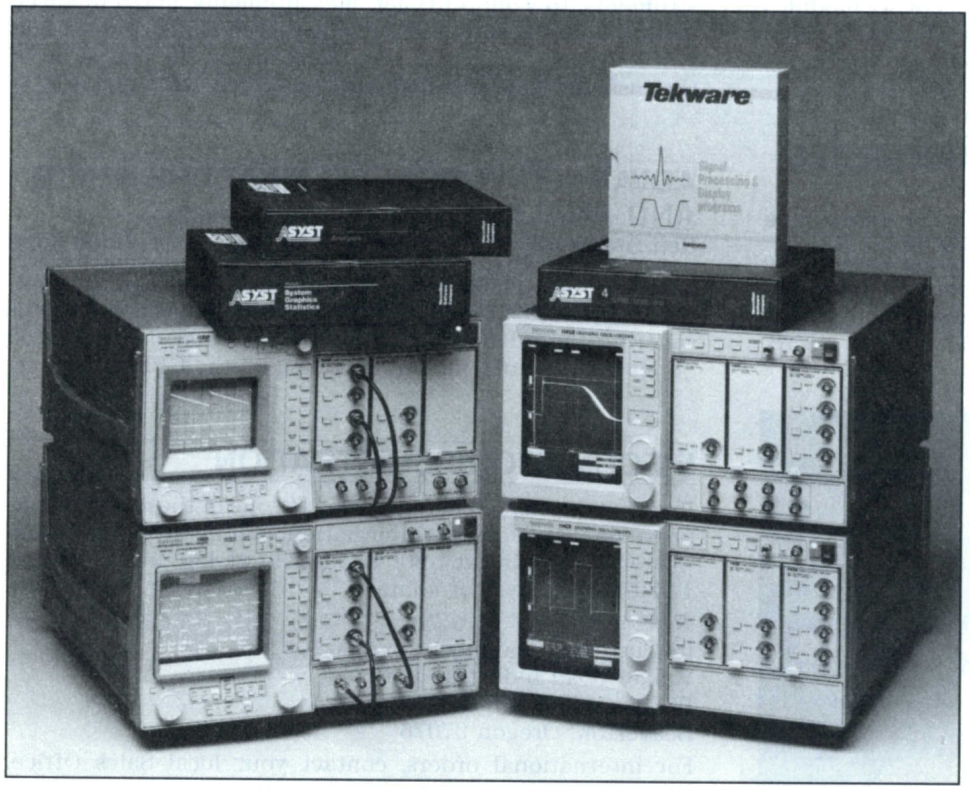
INFORMATION/REGISTRATION

If you are interested in registering for one of these workshops or would just like more information, call Instruments Group Customer Training at 1-800-835-9433 Ext 430. In Oregon call 1-629-1017 collect, or contact:

Tektronix, Inc
IG Customer Training
Walker Road Industrial park
PO Box 4600, M/S 94-953
Beaverton, Oregon 97076

For international orders, contact your local Sales Office. Tektronix reserves the right to cancel or reschedule a workshop.

11000-SERIES PROGRAMMABLE ANALOG AND DIGITIZING OSCILLOSCOPES



CONTENTS

11301 Programmable Analog Oscilloscope 226
11302 Programmable Analog Oscilloscope with Microchannel-Plate CRT 226
11401 Programmable Digitizing Oscilloscope 233
11402 Programmable Digitizing Oscilloscope 233
11A71 Single-Channel Vertical Amplifier 238
11A52 Two-Channel Vertical Amplifier 239
11A32 Two-Channel Vertical Amplifier 240
11A34 Four-Channel Vertical Amplifier 240
11A33 Differential Comparator . . . 241
P6134 10X Passive Probe 242
P6135 10X Differential Passive Probe 242
P6231 10X Active Probe 242
P6701 Optical-Electrical Converter 496
P6702 Optical-Electrical Converter 496

THE NEW STANDARD IN DIGITIZING AND ANALOG OSCILLOSCOPES

We set out to create a line of scopes that meet some very demanding requirements.

- The bandwidth must be high to meet present and future measurement needs.
- The architecture should be open and flexible and, thereby, avoid obsolescence. It should provide hardware and software modularity, yet be reliable and easy to service.
- All functions must be programmable, both for systems applications and to help with front-panel set-up.
- The user interface should be intuitive, giving easy access to a broad feature set.
- The scopes should offer more channels and more traces to stay relevant to the needs of today's design engineers.
- The instruments should be a good value, containing the best feature set possible in a moderately priced package.

We are proud to be able to offer this line and confident that we accomplished what we set out to do. This line of analog and digitizing oscilloscopes sets new standards in many key areas.

For characterization of waveforms, the 11000 Series offers:

- Higher levels of accuracy than any other oscilloscope system. This feature is accomplished through the use of the unique "Enhanced Accuracy" mode, which provides an automatic self calibration of the oscilloscope's vertical and horizontal systems against a built-in stable dc source. Vertical measurement accuracies to ≤1% may be attained through the use of Enhanced Accuracy. The built-in counter/timer in the 11301 and 11302 and the precise digitizing clock in the 11401 and 11402 provide accuracies in parts per million for timing measurements.
- Longer record lengths and more waveform memory. Multiple 10,240-point records and up to 102,400 points of waveform memory let users digitize and store more data than ever before without tying up a computer.
- Unmatched waveform processing and automatic measurement features to quickly perform measurements that used to take hours.

For prototype troubleshooting and debugging, the 11000 Series offers:

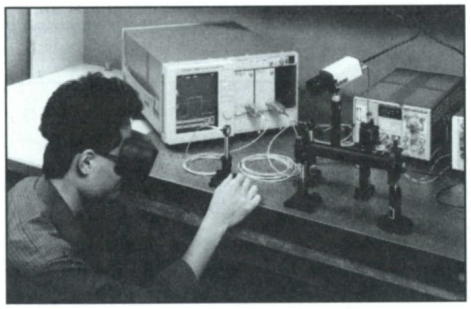
- High resolution, exclusive high-writing-rate microchannel plate CRT displays for viewing statistical fluctuations and fault conditions, or for catching glitches.
- A full line of probes and vertical amplifiers that can adapt the scope system to a broad range of digital and analog, electrical and optical signals.

For measurement against a standard, the 11000 Series offers:

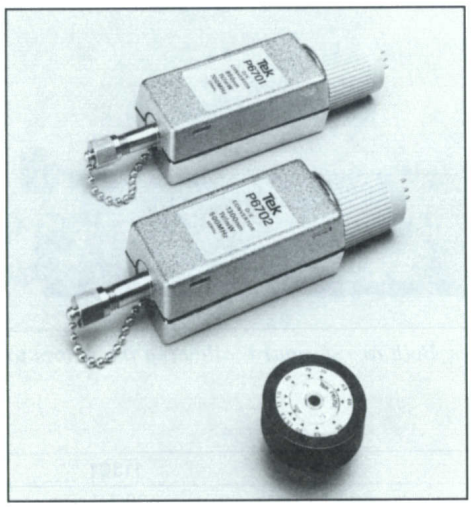
- Programmability through either GPIB or RS-232C.
- High measurement throughput to help meet tight production schedules.
- High reliability to make sure that your system stays up and running.
- On-site Warranty-Plus service options with fast response, and extensive diagnostics help get things back on-line quickly when you can't afford system down time.

BANDWIDTH

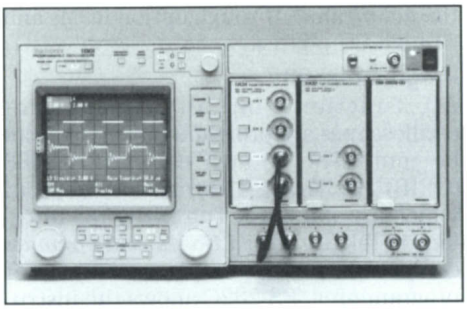
The 500-MHz microchannel-plate 11302 and 400-MHz bandwidth 11301 Analog Oscilloscopes include a powerful 500-MHz counter/timer for making exacting timing measurements.



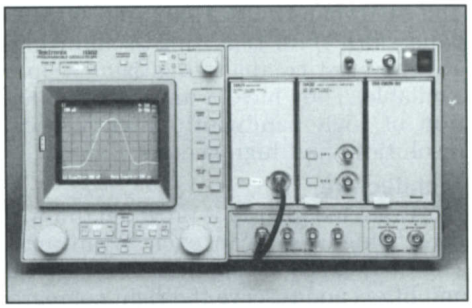
Optical waveform characterization is now much easier to do with the P6701 and P6702 Optical to Electrical Converters. The signals converted by these optical probes are then easily analyzed with the 11000-Series display and measurement system. See Accessories section for more information.



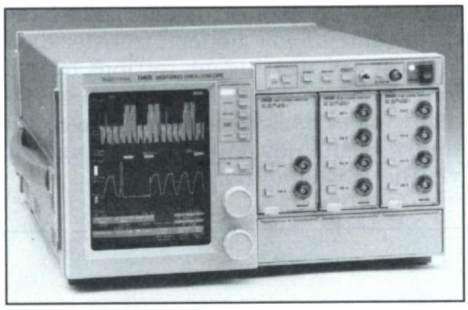
The response of the P6701 and P6702 is linear, dc coupled, calibrated, and high bandwidth. Measurement and scale-factor readout is in μW thanks to the TEKPROBE™ interface.



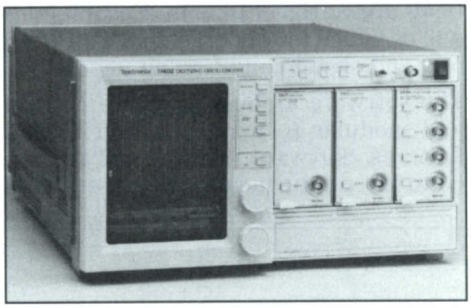
Large-screen 11301 provides clear crisp display of multiple waveforms, menus, and trace descriptions.



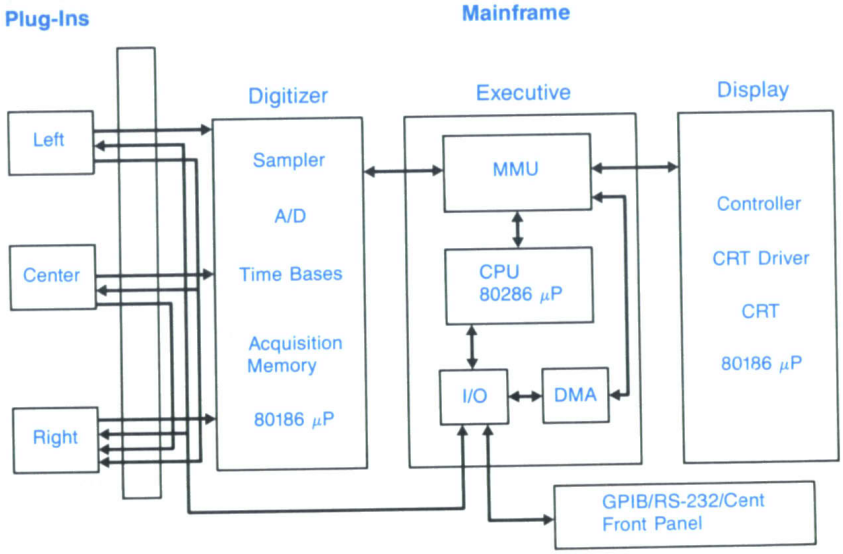
View single-shot transients at full 500-MHz bandwidth with the microchannel-plate CRT of the 11302.



The 11401 Digitizing Oscilloscope is a complete waveform digitizing, measurement, and storage instrument capable of capturing repetitive waveforms to 500 MHz.



The 11402 Digitizing Oscilloscope has all of the features of the 11401 with 1-GHz maximum system bandwidth.



The 11400-Series digitizing-scope architecture applies extensive processing power to waveform acquisition, measurement, and display.

The 1-GHz bandwidth 11402 and 500-MHz bandwidth 11401 Digitizing Oscilloscopes are the most complete digitizing scopes available. They have a unique combination of high bandwidth, high vertical resolution, and high accuracy.

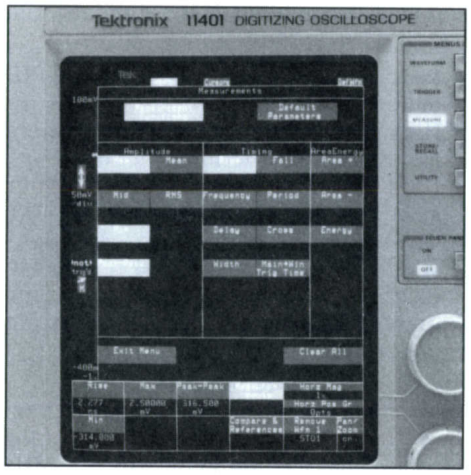
Architecture

Hardware modularity is provided through three plug-in slots in each mainframe. The analog scopes support two vertical amplifiers and reserve the right compartment for triggering and other plug-ins. The digitizing scopes support up to three vertical amplifiers or combinations of verticals and a trigger plug-in. New plug-ins will be added to support stimulus, triggering, and signal conditioning needs.

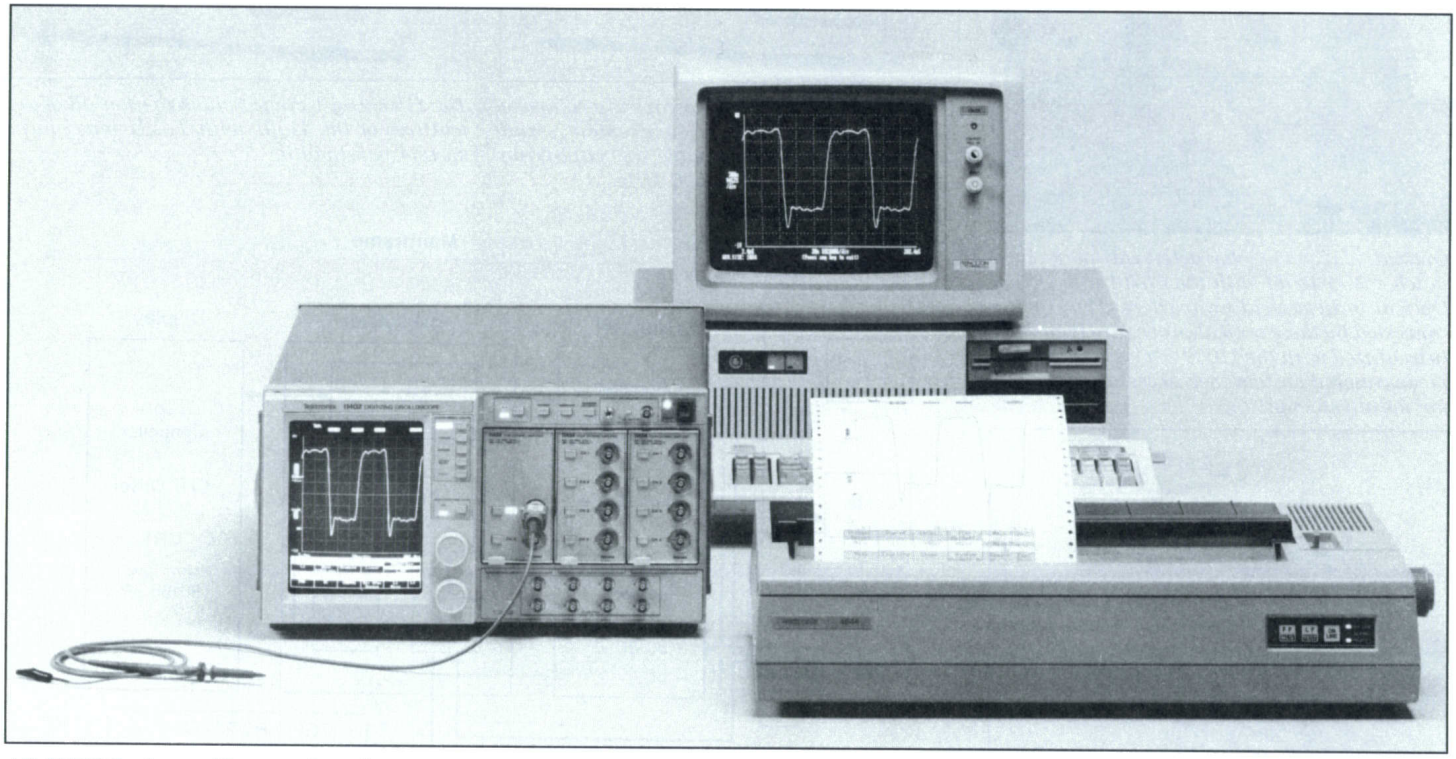
The software architectures are general and modular to make it easier to add features. Software features will be added to extend the measurement sets of all the mainframes through option ROMs and firmware updates.

Programmability

All functions on all 11000-Series oscilloscopes are programmable. They can be controlled through either IEEE-488 (GPIB) or RS-232C interfaces, both of which are standard. The IEEE-488 interface is Tek *Standard Codes and Formats* compatible for ease and consistency of programming. RS-232C allows the instruments to be easily controlled by personal computers. Both can also be used to transfer waveform and measurement data between the instruments and a large mainframe or, via modem, transfer data and control instrument settings over a long-distance link. A DMA option on the digitizing scopes speeds up waveform transfers, thereby improving throughput via the IEEE-488 port.



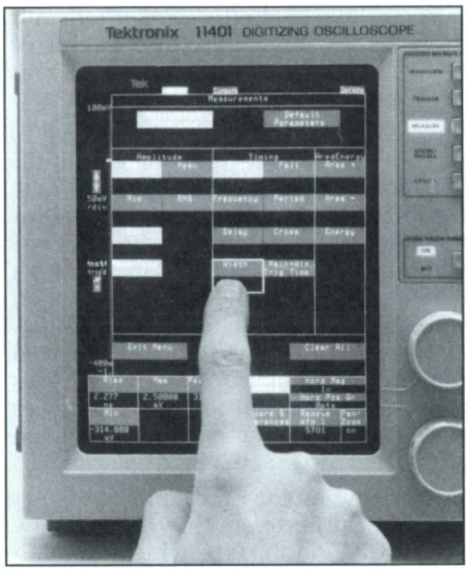
The 11401 and 11402 perform a wide range of amplitude, timing, and area/energy measurements. The measurements are automatic, accurate, easily accessible and clearly annotated for repeatable results.



All 11000-Series oscilloscope functions are programmable via either GPIB or RS-232C interfaces. Both are standard, allowing the scopes to easily interface with PCs, workstations, mainframe computers, and instrument controllers.

11000-SERIES MAXIMUM BANDWIDTH MATRIX

Plug-In	11402	11401	11302	11301
11A71 Single Channel, 10 mV/div, 50 Ω	1 GHz	500 MHz	500 MHz	400 MHz
11A52 Dual Channel, 1 mV/div, 50 Ω	600 MHz	500 MHz	400 MHz	350 MHz
11A32 Dual Channel, 1 mV/div, 1 MΩ/50 Ω	400 MHz	350 MHz	350 MHz	300 MHz
11A34 Four Channel, 1 mV/div, 1 MΩ /50 Ω	300 MHz	300 MHz	250 MHz	250 MHz
11A33 Differential Comparator, 1 mV/div, 50 Ω/1 MΩ/1 GΩ	150 MHz	150 MHz	150 MHz	150 MHz



Simply touch up to six measurements and see the results quickly.

User Interface

Clean, consistent, tested and intuitive, the 11000-Series user interfaces make measurements easy. Parallel menus and touch screens keep the number of buttons and knobs down to a manageable few. All frequently used controls are conveniently grouped around the display where the user's attention is already focused. There is no fumbling around a complicated front panel hunting for the right switch or button.

The touch screen is proven and reliable. Fingerprints, grease, dust, and grime are not a problem.

The 11000-Series user interfaces provide the closest link possible between the engineer and the scope.

More Channels

All of the mainframes can display up to eight active traces, more than any other scope system.

The analog scopes can display traces from:

- Up to eight high-bandwidth plug-in channels.
- Two triggerable delayed sweeps or window waveforms.
- A counter-view trace.
- Template waveforms stored in memory.

The digitizing mainframes can display eight traces, which may be any combination of:

- Live waveforms from up to 12 high-bandwidth channels.
- Window waveforms (similar to delayed sweeps).
- Stored waveforms
- Mathematical combinations of live or live and stored waveforms.

These display features simplify measurements, make new measurements possible, and make the 11000 Series ideal for prototype debugging and troubleshooting on printed-circuit boards and custom ICs, where multiple channels of data need to be viewed on the same screen.

A Good Value

These scopes deliver higher performance at a better price than any other scopes now available.

High-speed transient digitizers are still very costly and power hungry. The high-resolution, high-bandwidth A/D system in the 11401 and 11402 is a cost effective way to apply digitizing techniques to a wide variety of measurement problems.

The 11402 offers the lowest cost per channel of any high-bandwidth scope in its class.

The 11301 and 11302 both contain a built-in 500-MHz universal counter/timer. Yet the 11301 mainframe costs only about what you would pay for a standalone counter with similar performance. The microchannel-plate 11302 is available for no more than earlier conventional 500-MHz scopes without the counter/timer. The combination of the scope and counter/timer gives users much greater value than any scope or counter by itself.

Diagnostics with greater reach and broader coverage than in any other Tek products make the 11000 Series easier to calibrate and service. Cost of ownership is low due to high levels of integration and few moving parts. High measurement throughput on both the analog and digitizing scopes help customers lower their testing costs, and on-site service options keep down time to a minimum.

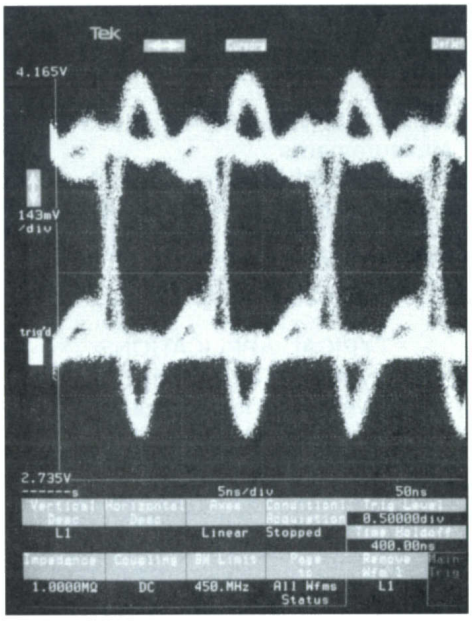
Enhanced Accuracy

The 11000-Series oscilloscopes provide measurement accuracies well beyond those available in any other current oscilloscope or oscilloscope system. This feature is accomplished through the unique "Enhanced Accuracy" mode, which may be invoked whenever measurement accuracy is a primary consideration.

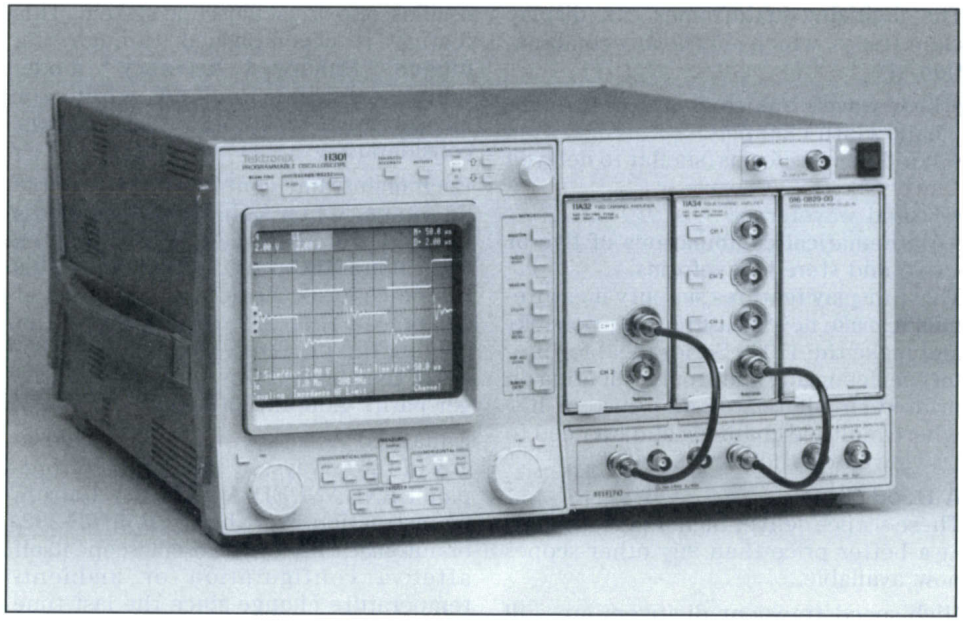
Each mainframe contains its own stable dc source. When Enhanced Accuracy is invoked, the instrument goes through a self-calibration routine that uses this reference to set the dc gain and offset of each channel of the vertical system (including the plug-ins), the gain and timing of the horizontal system, and the trigger path's gain and offset.

Enhanced Accuracy may be invoked in any of three ways: by pressing the front-panel ENHANCED ACCURACY button, by instruction over the GPIB or RS-232, or automatically by the oscilloscope itself after a configuration or ambient-temperature change since the last time Enhanced Accuracy was performed.

Enhanced Accuracy permits the specification of much tighter tolerances on dc gain and timing of the 11000-Series oscilloscope systems than are feasible on conventional oscilloscopes. Once Enhanced Accuracy has been performed, the instrument will remain within the Enhanced Accuracy tolerances through any ambient-temperature change of 5 °C or less.



Eye patterns can be created for checking bit error rates on communications systems.



11300 Series

GPIB IEEE-488 The 11300 Series complies with IEEE Standard 488-1978, RS-232C, and with Tektronix *Standard Codes and Formats.*

- **Up to 500-MHz Bandwidth**
- **Built-In 500-MHz Universal Counter/Timer with Counter View**
- **Up to 8 Traces Displayed Simultaneously**
- **Menu-Driven Touch-Screen Operation**
- **Automatic Display of Selected Signals**
- **Automatic Time and Amplitude Measurements**
- **Dual Delayed Sweeps**
- **6-cm/ns Visual Writing Rate (11302)**
- **Large 6.5-Inch Display (11301)**
- **Fully Programmable via IEEE-488 & RS-232C**

TYPICAL APPLICATIONS

Timing Analysis of Complex Signals
Waveform Characterization
Component Evaluation

The 11301 and 11302 are easily the world's most versatile analog oscilloscopes. These oscilloscopes are fully programmable via either IEEE-488 or RS-232C, with any RS-232 equipped personal computer. They are equally at home in the most complex automated production-test system or in smaller scale computer-assisted testing and data-logging applications in the engineering environment. For manual operation, the menu-driven touch-screen operator interface places the 11301 and 11302 a step beyond anything presently available in convenience of use. Manual control of the instruments, including their plug-ins and probes, is accomplished by means of a few pushbuttons and two user-definable knobs located in the vicinity of the cathode-ray tube and the touch-panel CRT screen itself. Operator menus on the screen guide the user through the selection of the functions to be performed; selection is made by touching the designated areas of the screen.

CRT readout displays oscilloscope and plug-in settings, as well as numeric readout of desired measurements; no more need to count or interpolate between graticule divisions. Using IEEE-488 or RS-232C, up to eight lines of user-generated text (50 characters per line) can be displayed on the CRT for operator prompts, measurement annotation, and computer-generated menus. The large CRT screen provides clear, crisp display of both text and traces.

Wide Choice of Plug-Ins

A choice of five amplifier plug-ins provides display of up to eight traces at 250-MHz bandwidth, four traces at 400 MHz, or two traces at 500 MHz. The differential-comparator amplifier unit provides exceptionally fast overdrive recovery from signals as high as 8 V at 1-mV/div sensitivity.

The 11301 and 11302 each accept up to three of the 11000-Series plug-in units. Signals from the amplifier plug-ins may be directed to either the vertical or horizontal system of the oscilloscope where they may be time shared with main or delayed sweeps. This allows an almost unlimited number of combinations of X-Y and Y-T traces to be displayed simultaneously to provide detailed views of signal relationships. Timed X-Y traces may be displayed through the application of delayed sweeps to X-Y displays.

Each of the inputs on each of the plug-ins is supported by the new TEKPROBE™ interface which, in addition to the high-quality signal path, also provides probe power for active probes and a communication link between the probe and the oscilloscope.

Built-In 500-MHz Universal Counter/Timer

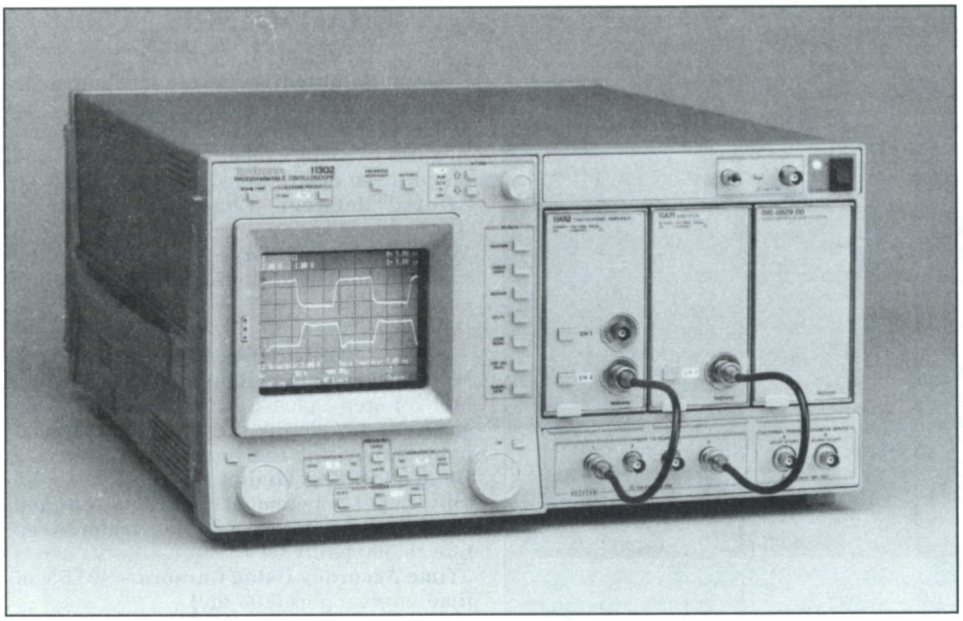
The built-in 500-MHz Universal Counter/Timer, with its 2-ns single-shot resolution, performs as an integral part of the 11301/11302. This combination of high-performance counter and high-performance oscilloscope greatly simplifies the most difficult counter/timer measurements and provides measurement capabilities not possible with conventional counter/timers. A counter-view trace indicates to the operator exactly what portions of a signal are being measured by the counter/timer. This completely eliminates the concern that usually accompanies the measurement of complex signals with a conventional counter, whether what is being measured is really what the operator thinks is being measured.

The combination of integral oscilloscope and counter/timer allows you to make counter/timer measurements on any of 12 plug-in input channels or on the signals at the A and B External Trigger/Counter Inputs. Use of the A and B External Trigger/Counter Inputs allows the use of the counter/timer without tying up the oscilloscope functions of the instrument.

High-Writing-Rate CRT in 11302

The microchannel-plate CRT of the 11302 provides 6-cm/ns visual writing rate, bright enough to view the fastest single-shot transient in normal ambient room light. This allows viewing of intermittent glitches in the midst of bright repetitive signals at the full bandwidth of the scope.

TEKPROBE is a trademark of Tektronix, Inc.



Automatic Display Setup

The Autoset feature provides scaled, triggered display of the selected signal immediately, automatically, with the simple press of a button on the front panel or at the probe tip where the user's attention is focused.

Automatic Measurements

The press of a front-panel pushbutton and a touch of the touch screen provides automatic time and amplitude measurements, without further operator intervention. This automatic measurement sequence can also be invoked via the probe-tip pushbutton, allowing the operator to display the results of up to eight measurements without removing hands or attention from the circuit under test.

Cursors

Both vertical and horizontal cursors can be displayed to aid in making amplitude and timing measurements. Cursor scaling permits percentage, dB, and degree comparisons without the need for calculations. The results of the measurements are always displayed numerically on the screen, with appropriate units of measure.

Built-In Time Bases

Two built-in time bases provide sweep rates to 500 ps/div. The dual delayed sweeps provide magnification of any portion of the displayed waveforms and allow precise comparison of two signals occurring at different times in the same or different signal paths.

Display Versatility

The versatile and convenient trace definition capability of the 11301 and 11302 permits up to eight traces to be displayed simultaneously in a wide variety of signal combinations. Signals from separate plug-ins can be added or subtracted; YT and XY signals can be displayed simultaneously.

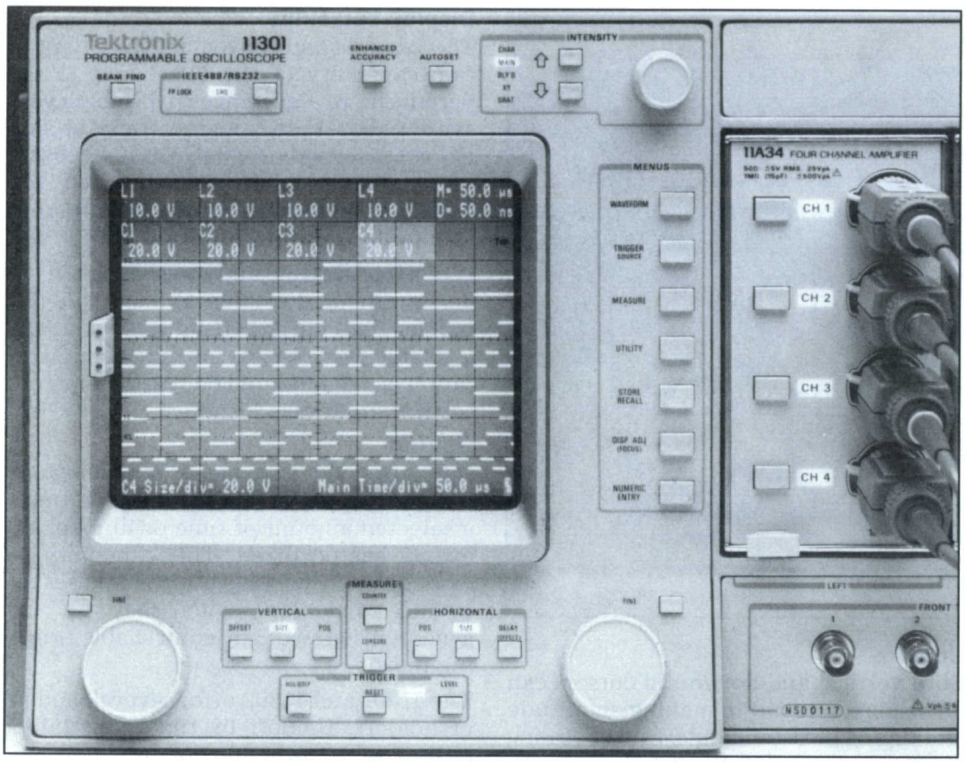
A nonvolatile time and date clock can be displayed for documentation of photographs. The clock setting is constantly available over the bus for time documentation of accumulated data in automated testing situations.

Holdoff

Holdoff provides the means of holding off the occurrence of the main sweep until a selected amount of time or number of events has occurred. This capability is essential in inspecting groups of pulses or events, particularly when they are not synchronized with any controllable framing pulse.

The 11301 and 11302 offer several modes of holdoff. Holdoff by time is settable either as a function of main-sweep time/division or in 2-ns increments up to 0.99 seconds. Holdoff by events is settable up to 500,000 events.

The Countdown Holdoff function allows the sweep to be triggered on every Nth event within a pulse train. The Trigger-On-Next/Trigger-On-Previous function allows the user to move forward and backward through the pulse train in order to select the desired triggering point within the pulse train. Thus, any pulse within the pulse train can be inspected in detail and easily compared to other events occurring within a circuit at the same time.



Both 11000-Series mainframes easily display eight separate traces with the deflection factor of each conveniently displayed on screen. All oscilloscope control is centered on or near the CRT, "where the action is."

The Holdoff by Events function permits the main sweep to run immediately, or be armed for triggering by another signal source, after N events following a selected start event. This function, in effect, permits four-deep "stacking" of delaying events: a start event, followed by a selected number of holdoff events, followed by a main-sweep triggering event, followed by the running or triggering of one or both delayed sweeps.

Calibrated Fine Settings

A fine-settings mode provides calibrated sweep timing and vertical sensitivity to 1% increments between the conventional 1-2-5 settings. This permits the operator to take advantage of full scale, vertically or horizontally, for increased measurement accuracy.

Stored Front-Panel Setups

Up to 10 complete front-panel setups can be stored and recalled for immediate setup of all instrument controls for repetitive testing. Manual sequencing of the stored setups can be accomplished by means of the pushbutton at the probe tip. This allows the operator, probing from point to point within a circuit, to reset the entire oscilloscope for each test point without removing attention from the device being tested.

Reference Waveforms

On-board storage and display of two reference waveforms can provide templates for quick visual go/no-go comparison of complex waveforms. These reference waveforms can be created by a computer or captured by a waveform digitizer and downloaded to the oscilloscope's internal memory.

Direct Numeric Entry, with Arithmetic Operators

A touch-screen keypad permits immediate numeric entry of scale factors, holdoff events, offsets, counter/timer, cursor null references, etc.

CHARACTERISTICS

VERTICAL SYSTEM

System Bandwidth—Determined by main frame and plug-in. (See Maximum Bandwidth Matrix in the 11000-Series Reference section.)
Accuracy—Determined by mainframe and plug-in. See descriptions.
ΔDelay Between Channels—Adjustable ±500 ps.
Vertical-System Delay—At least 20 ns of the sweep is displayed ahead of the triggering event.

HORIZONTAL SYSTEM

Main-Sweep Timing Range—5 ns to 0.5 s/div in 1-2-5 steps, plus 1% increments between steps and to 1.0 s/div. X10 Mag extends maximum sweep rate to 500 ps/div.
Delayed-Sweep Timing Range—5 ns to 0.5 s/div, plus 1% increments between steps and to 1.0 s/div. X10 Mag extends maximum sweep rate to 500 ps/div.
ΔTime Accuracy Using Cursors—±(0.5% of time interval plus 0.03 div).
ΔTime Accuracy Using Delayed Sweep—±(0.03% of time interval plus 0.01 div).
X-Y Operation—From Center Plug-In: Horizontal bandwidth is dc to 3 MHz; phase difference between X and Y with normal bandwidth is 1° or less from dc to 1 MHz, 3° or less from 1 to 2 MHz.

TRIGGERING

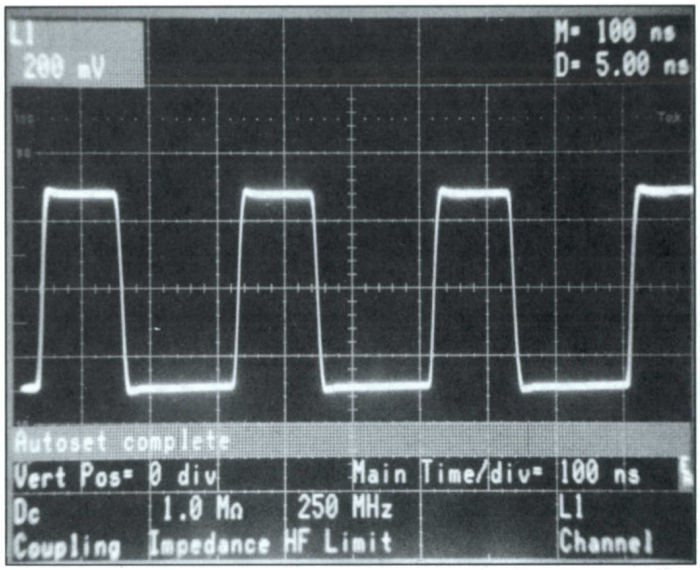
Minimum p-p signal required for stable triggering.
DC Coupled—0.35 div from dc to 50 MHz; increasing to 1.0 div at system bandwidth.
AC Coupled—0.35 div from 50 Hz to 50 MHz, increasing to 1.0 div at system bandwidth.
HF Reject Coupled—0.5 div from dc to 30 kHz.
LF Reject Coupled—0.5 div from 80 kHz to 50 MHz, increasing to 1.0 div at system bandwidth.

Triggering sensitivity can be adjusted to reject unwanted noise components on noisy signals.

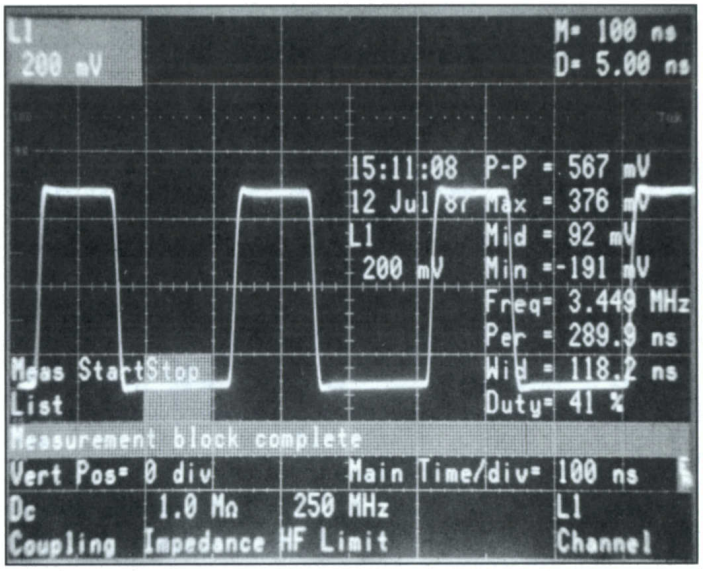
Minimum p-p signals required for stable triggering from A and B external inputs:

DC Coupled—20 mV from dc to 50 MHz, increasing to 150 mV at system bandwidth.
AC Coupled—20 mV from 50 Hz to 50 MHz, increasing to 150 mV at system bandwidth.
HF Reject Coupled—28 mV from dc to 30 kHz.
LF Reject Coupled—28 mV from 80 kHz to 50 MHz, increasing to 150 mV at system bandwidth.

Triggering sensitivity can be adjusted to reject unwanted noise components on noisy signals.



A press of a button at the probe tip or on the front panel automatically sets up the controls of the 11300 oscilloscopes for a triggered on-screen display of the selected signal.



The 11300 oscilloscopes make up to eight measurements, automatically, on the selected signal.

HOLDOFF

Holdoff By Time—Range: At least 20 times the inherent minimum reset time of the sweep (function of time/div).
Holdoff By 2-ns Step—Settable in 2-ns increments from minimum inherent period of the sweep (function of time/div) to 966 msec.
Countdown Holdoff—Settable from 2 to >500 million events. Maximum event frequency is 100 MHz.
Holdoff By Events—Settable from 2 to >500 million events. Maximum event frequency is 500 MHz. (One Start mode limits event frequency to 100 MHz.)

BUILT-IN COUNTER/TIMER

Modes—Frequency, Period, Width, Ratio, Time A→B, Totalize.
Number of Digits—Up to 7; up to 10 with optional high-stability time base (Option 1T). (System computes and displays proper number of valid digits for specific measurement.)
Averaging—Selectable in two-decade steps (1, 10^2, 10^4, 10^6, etc.) up to 10^{10} for frequency, period, width, ratio, and time A→B measurements. Auto Average provides maximum resolution achievable with a 3 readings/s update rate.
Gating—Via External B input or internal delayed sweep gate, or open on External A and close on External B. Minimum external gate width: <25 ns.
Counter View—Shaped 1-div p-p display of any one or more of the following signals: Counter In, Gate, Sync Gate, A External Input, B External Input.
Sensitivity—Via Plug-In Inputs: 2X sweep-triggering sensitivities. Via External A and B Inputs: <100 mV p-p dc to 100 MHz, increasing to 500 mV p-p at 500 MHz.
Counter Ref Clock In/Out—Connector on rear panel allows application of 0-dBm 10-MHz external clock.

Trigger-Level Range—Plug-Ins: ±10×size/div setting. External A and B Inputs: ÷1, ±500 mV; ÷5, ±2.5 V.
Trigger-Level Accuracy—Internal: Add ±2% to plug-in unit's ΔV DC term (where ΔV is the Level Readout minus Amplifier Offset) divided by V/div, add 0.3 div to DC Balance term, and add peak noise in divisions. (Peak noise is 5×RMS.)

External A and B Inputs (for signals with 10% to 90% transition time >10 ns)—
÷1 (max signal, ±1V): ±[3% of setting +4% of p-p signal+10 mV +(0.5 mV times probe attenuation factor)].

÷5 (max signal, ±5 V): ±[3% of setting +4% of p-p signal+50 mV+(0.5 mV times probe attenuation factor)].

FREQUENCY

Range—<1 mHz to 500 MHz.
LSD—Greater of $\frac{1.8\ \text{ns}\times F^2}{N}$ rounded to the next higher decimal digit, or 1 count.
Resolution—Greater of LSD ±1.4 (TJE)F^2/N.
Accuracy—Resolution ±F (TBE).

PERIOD

Range—2 ns to 1250 hrs.
LSD—1.8 ns/N
Resolution—LSD±1.4 (TJE)/N.
Accuracy—Resolution±TBE (P).

WIDTH

Range—2 ns to 1250 hrs.
Maximum Repetition Rate—200 MHz.
LSD—2 ns (for N=1);
10 ns/$\sqrt{N}$ (for N>1).
Resolution—(LSD±1.4 (TJE_L)±1.4 (TJE_T))/$\sqrt{N}$±2 ps.
Accuracy (Gated and Nongated)—Resolution±Width (TBE)
±Hysteresis error
±TLE/($Slew_E$−$Slew_S$)±1 ns.

TOTAL

Range—0 to 10^{15} counts (engineering notation used above 10 digits).
Repetition Rate—>0 to 500 MHz.
LSD, Resolution, and Accuracy—1 up to $10^{11}-1$.
Elapsed Time Range—25 ns to 1250 hrs.

RATIO

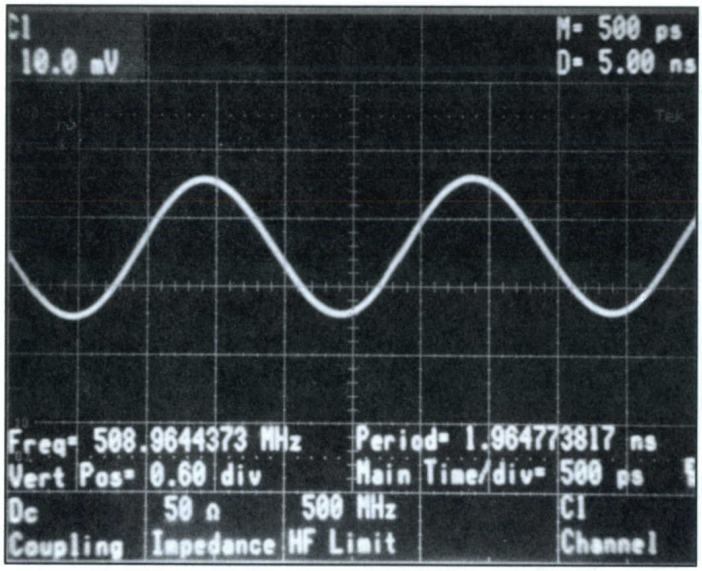
Range—10^{-11} to 10^{11}.
Frequency Range—1 Hz to 400 MHz.
LSD—Ratio/10^{10}.
Resolution—LSD±1.4 (TJE_D)N_D±1.4 (TJE_M/N_M)±F_D^2±F_MF_D) where N refers to trigger events.
Accuracy—Same as resolution.

TIME INTERVAL
(Main and Delay Trigger Sources)

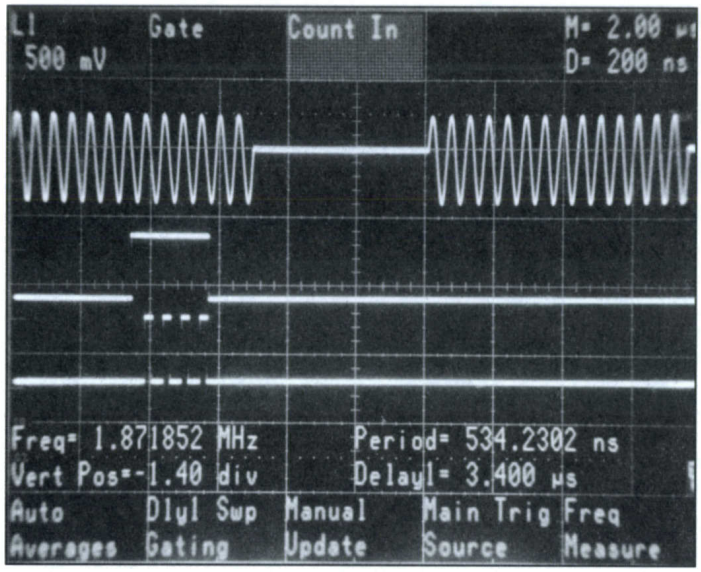
Range—2 ns to 1250 hrs.
LSD—2 ns (for N=1);
10 ns/$\sqrt{N}$ (for N>1).
Resolution—±LSD±(1.4(TJE_M)+TJE_D)/$\sqrt{N}$+2 ps.
Accuracy—±(TBE)(Time Interval)±Resolution
±Plug-In Delay Mismatch
±TLE_M/Slew
−TLE_D/Slew
±200 ps.
Maximum Repetition Rate—200 MHz.
Channel Delay Mismatch—Not more than ±500 ps (without null).

STANDARD TIME BASE

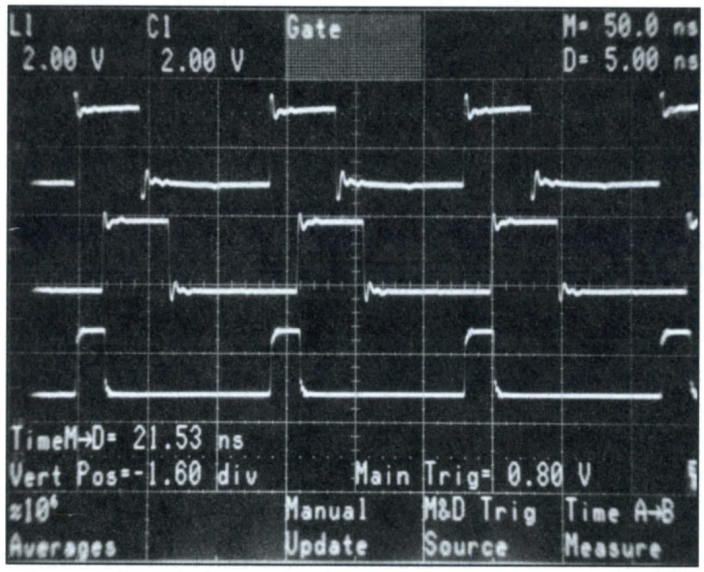
Frequency at Calibration—10 MHz ±1 Hz.
Temperature Stability—±50 Hz, 0 to 50°C (5 ppm).
Aging—<10 Hz/year (1 ppm).
Adjustment Resolution—0.5 Hz.



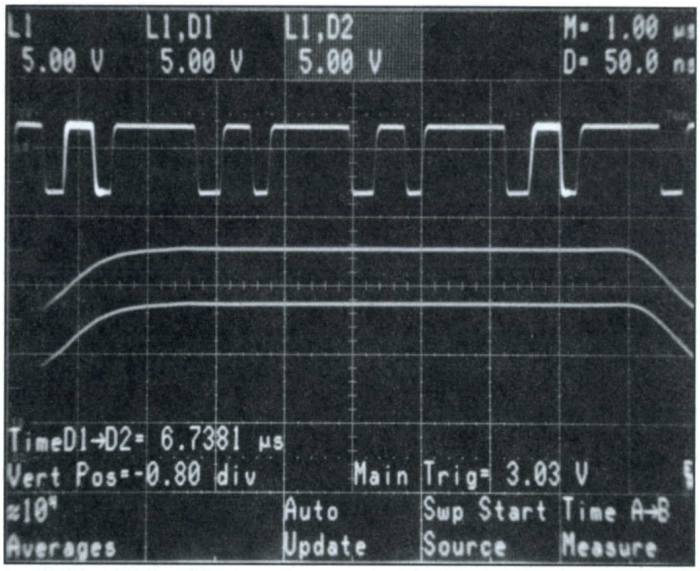
The 500-MHz combination of 11302 mainframe and 11A71 single-trace amplifier allows accurate frequency measurements of small signals to 500 MHz or more with 113000's built-in universal counter/timer.



The 11300 oscilloscope delayed sweep supplies the gating signal (middle trace) for burst measurements. The Count In trace (bottom trace) shows the events being counted during the gate interval.



Here the 11300 universal counter/timer measures 21.53 nanoseconds of propagation delay between the leading edge of signal L1 (left plug-in, channel 1) and the leading edge of signal C1 (center plug-in, channel 1). Gate trace (bottom trace) clearly shows the time interval being measured.



Very accurate pulse-to-pulse timing measurements within a complex pulse train are made simple with the 11300 universal counter-timer and dual delayed sweeps.

HIGH STABILITY TIME BASE (OPTION 1T)

Frequency at Calibration—10 MHz ± 0.2 Hz.
Temperature Stability—±2 Hz, 0 to 50 °C.
Warm-Up Time—10 minutes at 25 °C to within 0.2 ppm of final frequency.
Aging—$<1\times10^{-8}$/day at time of shipping. $<4\times10^{-8}$/week after 30 days continuous operation. $<1\times10^{-6}$/year after 60 days continuous operation.
Short-Term Stability—$<1\times10^{-9}$ RMS based on 60 consecutive 1-s measurements.
Adjustment Resolution—0.2 Hz.
Adjustment Range—Sufficient for 8 years of aging.

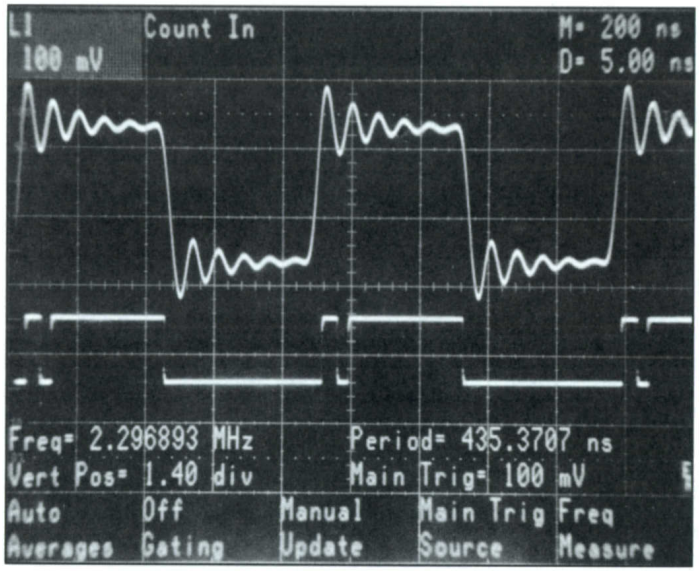
DEFINITION OF TERMS

LSD = The smallest amount that the display can change.
N = Number of events in a measurement interval.
P = The period of the signal being measured.
RESOLUTION = The amount an input signal must change to be assured of a change on the display.
TBE = Time-base error.
TJE = Trigger-jitter error (in seconds RMS) =

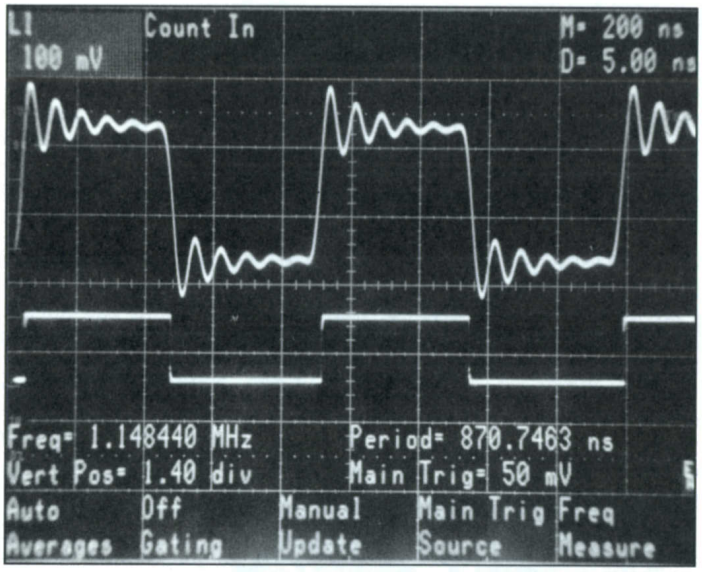
$$\frac{\sqrt{(e_nS)^2+(e_nP)^2+(e_nM)^2}}{\text{input-signal slew rate}}$$

where e_nS = Input-signal RMS noise voltage
e_nP = RMS noise voltage contributed by plug-in (see plug-in characteristics).
e_nM = 0.05 div when using plug-in; 5 mV when using Ext. A or B input.

TLE = Trigger-level error; error resulting from the actual trigger point being different from the set trigger point.



The Count In trace (lower trace) shows clearly that the counter/timer is miscounting because of the ripple on the top of the signal.



Here the Count In trace (lower trace) shows that the counter/timer is being properly triggered for the desired measurement.

EXTERNAL CONNECTORS

Camera Power—3-pin connector next to CRT is compatible with Tektronix C-50 Series cameras.

Calibrator Output—Front-panel female BNC connector. Square-Wave Mode: 5.0 V or 500 mV square wave into open circuit; 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz; 450-Ω output impedance. Fast-Rise Mode: 0.5 V into open circuit, 2-ns transition time into 50 Ω; 50-Ω output impedance; same frequencies as Square-Wave Mode plus 1 MHz.

A and B External Trigger and Counter Inputs—Front-panel female BNC connectors. Input impedance: 1 MΩ.

Trigger Ready Output—Rear-panel female BNC connector. TTL compatible; high state indicates Trigger-Ready condition.

Trigger Reset Input—Rear-panel female BNC connector. TTL compatible; high-to-low transition resets counter and/or single sweep.

Sweep Gate Output—Rear-panel female BNC connector. TTL compatible; high state indicates gate running. Main or delayed gate out selectable through UTILITY menu.

Left Vertical Out—Rear-panel female BNC connector. Output-signal amplitude = 100 mV/div ±10% of displayed signal. Bandwidth = dc to 100 MHz. Output impedance = 50 Ω ±10%.

Counter Ref Clock In/Out—Rear-panel BNC connector. See Counter/Timer description.

Main-Sweep Output—Rear-panel female BNC connector. Positive-going ramp, 0 to 5 V, coincident with main sweep: Output impedance: 950 Ω.

Z-Axis Input—Rear-panel female BNC connector. Positive voltage decreases intensity; +3 V blanks a maximum-intensity trace.

RS-232-C—25-pin "D" female connector configured as DCE.

IEEE-488—24-pin female connector for connecting instrument to GPIB.

PHYSICAL CHARACTERISTICS

Instrument	11301		11302		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
Width, with handle	447	17.6	447	17.6	482	19.0
Height, with feet	239	9.4	239	9.4	222	8.8
Depth	581	22.9	581	22.9	548	21.6
Weight ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	18.1	40.0	20.0	44.0		
Shipping	21.8	48.0	23.6	52.0		

CRT AND DISPLAY FEATURES

Standard CRT—11301: 8×10 div (1.22 cm/div); P31 phosphor. 11302: 8×10 div (1.0 cm/div); P31 phosphor. 11302 Writing Speed: 10 div/ns single-shot visual writing speed in 20 fC ambient illumination.

POWER REQUIREMENTS

Line Voltage—90 to 132 V ac, and 180 to 250 V ac.

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—240 W.

ENVIRONMENTAL AND SAFETY

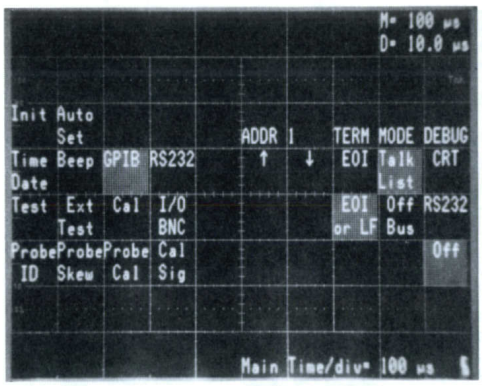
Temperature—Operating: 0 to +50°C. Nonoperating: −45 to +75°C.

Humidity—Operating and Nonoperating: Up to 95% relative humidity, up to 50°C.

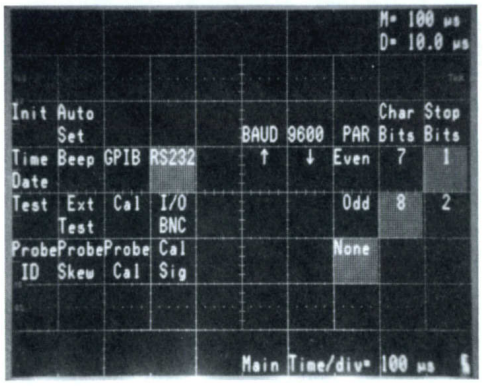
Altitude, Vibration, Shock, and Bench Handling—Meets MIL-T-28800C, Type III, Class 5.

Electromagnetic Compatibility—Meets MIL-T-28800C; MIL-STD-461B; FCC Part 15, Subpart J, Class B; VDE 0871/6.78 Class B; CE-01 Part 4, with exceptions; CE-03 Part 4, Curve 1; CE-03 Part 4, Curve 4, Navy, NB, BB (with exceptions); CS-01 Part 7; CS-02 Part 4 (with exceptions); CS-06 Part 5; RE-01 Part 4 (with exceptions); RE-02 Part 4; RS-01 Part 4; RS-03 Part 7 (limited to 1 GHz).

Safety—Listed UL 1244; CSA Bulletin 556B, September 1973; Tektronix self-certification to comply with IEC 348 recommendations.



The 11301 and 11302 are fully programmable over either GPIB or RS-232. Setup of the GPIB (above) and RS-232 (below) interfaces is done directly through a touch-screen menu.



ORDERING INFORMATION

11301 400-MHz Programmable Analog Oscilloscope **$8,550**
Includes: Operator manual (070-6104-00); user reference guide (070-6106-00); user pocket reference (070-6105-00).

11302 500-MHz Programmable Analog Oscilloscope With Microchannel-Plate CRT **$12,950**
Includes: Same as 11301.

OPTIONS

Option 1C—Adds four additional rear-to-front feedthroughs to the existing standard four; total of eight. **+ $150**
Option 1R—Rackmount **+ $250**
Includes: Hardware, tooling, and instructions for converting bench model to rackmount configuration.
Option 1T—High stability Counter/Timer. **+ $325**

CONVERSION KITS

Rackmount Adapter—To convert standard 11301 or 11302 to Option 1R. Order 040-1214-00 **$250**
High-Stability Counter/Timer—To convert standard 11301 or 11302 to Option 1T. Order 040-1232-00 **$325**
Four-Cable Feedthrough—To convert standard 11301 or 11302 to Option 1C. Order 040-1233-00 **$175**

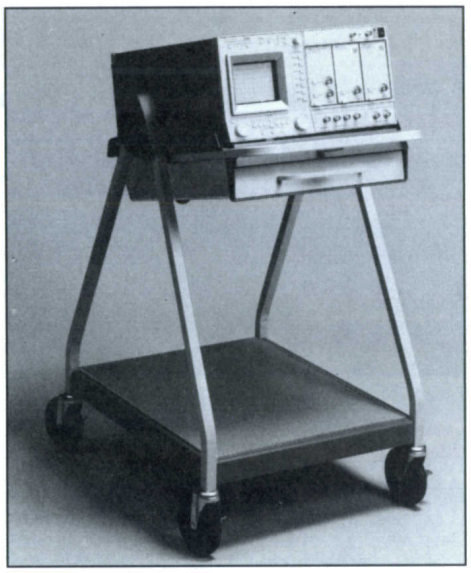
INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

11301 Service Manual—
Order 070-6980-00*[1]
11302 Service Manual—
Order 070-6781-00*[1]
Cables—
(GPIB) 2 m. Order 012-0991-00
(RS-232) 10 ft. Order 012-0911-00
Blank Panel—For filling empty plug-in compartments.
Order 016-0829-00

*[1] *To order, contact your local Tektronix Sales Office.*



K217 Instrument Cart with 11302. See Carts section for information.

DIGITIZING CAMERA SYSTEM

DCS01—Digitizes waveforms or single-shot signals to the full bandwidth of the 11302 to allow analysis with a personal computer. **$5,500**

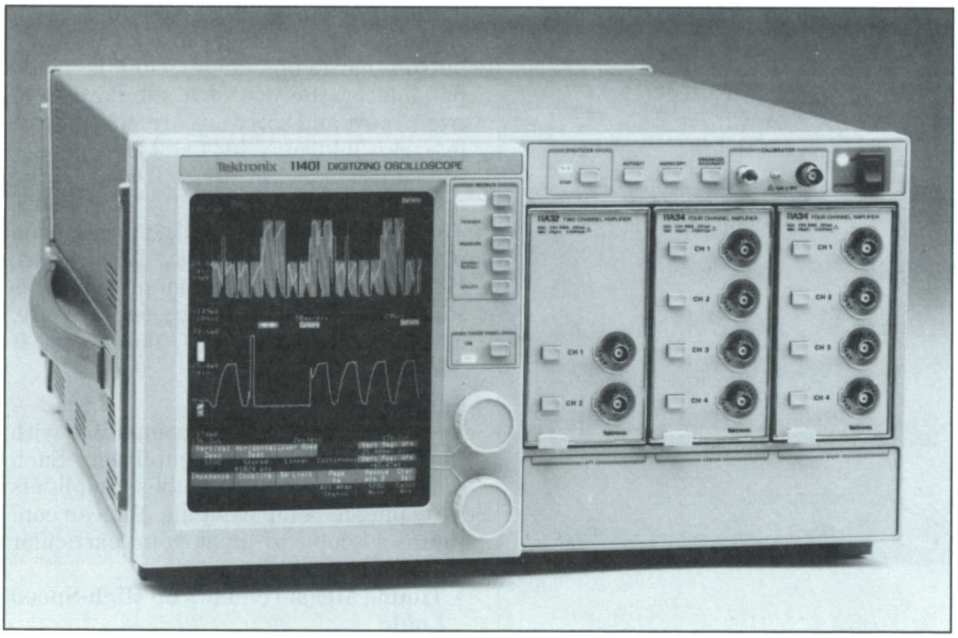
See Digitizers section for complete ordering information.

RECOMMENDED ACCESSORIES

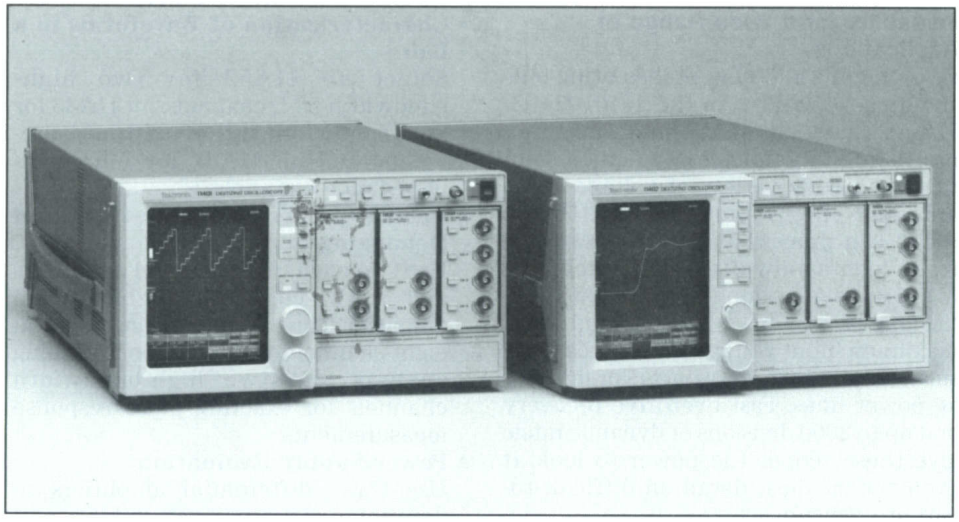
Cameras—See Camera and Mounting Adapter Selection Guide in the Accessories section.
Probes—See recommended probes later in this section.
Cart—K217. See Instrument/Cart compatibility chart in the Accessories Section.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is in the Customer Training Section. For further information, or to enroll, call us at 1-800-835-9433 ext. 430. In Oregon call collect 1-629-1017.



The 11401 Digitizing Oscilloscope with 500-MHz System bandwidth.



The 11401 and 11402 are the first in a line of high bandwidth, programmable digitizing oscilloscopes. The 11401/11402 are ideal for digitizing and accurately measuring repetitive waveforms. 10–14 bit vertical resolution, 20 MS/s A/D conversion system provides a cost-effective solution to a wide range of measurement problems.

11400-Series

Digitizing Oscilloscopes

GPIB IEEE-488 The 11400 Series complies with IEEE Standard 488-1978, RS-232C, and with Tektronix *Standard Codes and Formats.*

- **1-GHz and 500-MHz Bandwidth**
- **Eight Channels of Display and Acquisition**
- **Plug-In Modularity**
- **Waveform Processing and Automatic Pulse Parameters**
- **Multiple 10,240-Point Waveform Records**
- **Accepts Differential, High-Impedance, and 50-Ω-Input Amplifiers**
- **Greatly Simplified Access to Features**
- **Fully Programmable via GPIB and RS-232C**

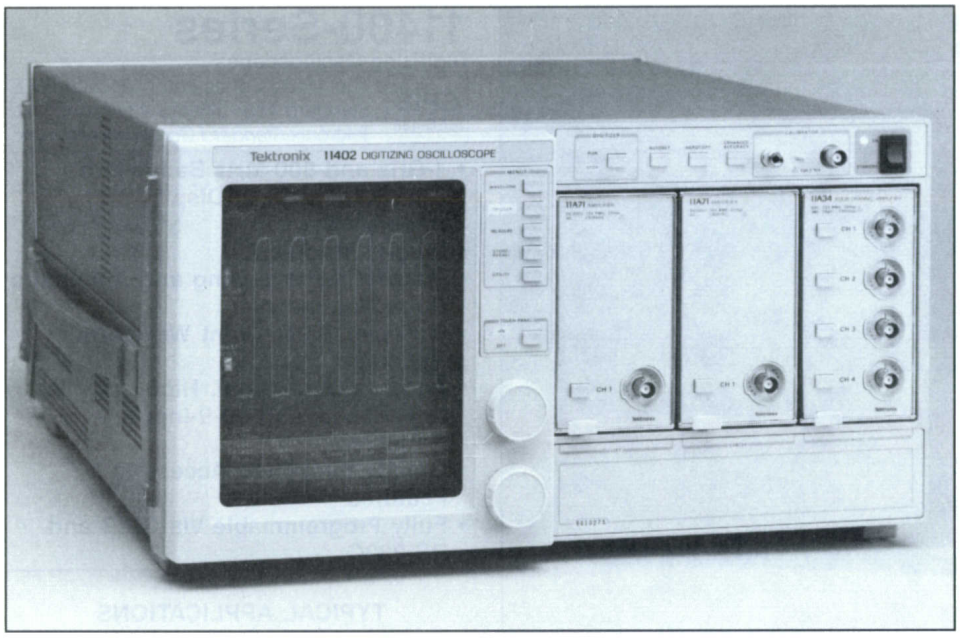
TYPICAL APPLICATIONS

Waveform Characterization
Prototype Troubleshooting and Debugging
Measurement Against a Standard

The 11401 and 11402 are the first in a new line of digitizing oscilloscopes. These versatile scopes, with their array of new supporting plug-ins and probes, solve measurement problems equally well on a designer's bench or in a programmable test system. Digital designers will benefit from flexible triggering features and an eight-channel display. Analog and power-supply designers can apply extensive waveform processing to signals acquired through high-performance differential and single-ended amplifiers. 11000-Series digitizing scopes can follow your designs into production. Full programmability via either IEEE-488 or RS-232C and features like a DMA controller for fast waveform transfers make these scopes a perfect fit for systems. 11000-Series digitizing oscilloscopes set new standards in performance.

Live Display of Up to Eight Traces

The 11401/11402 each support three vertical-amplifier plug-ins. This means you can acquire up to eight channels of data at 300 MHz, up to six channels of data at 600 MHz, or up to three channels of data at 1 GHz. You can, of course, mix and match the plug-ins to design the system that works best for you. Eight traces can be displayed at any one time so that you can get the whole picture on one screen. The update rate is so fast that the 11401 and 11402 have the look and feel of analog scopes.



The 11402 Digitizing Oscilloscope with 1-GHz System bandwidth.

High Vertical and Horizontal Resolution

The 11401 and 11402 uniquely combine wide bandwidth with 10-ps horizontal resolution and 10-bit vertical resolution (vertical resolution can be increased to 14 bits when signals are averaged). Other vendors have made a tradeoff: bandwidth for vertical resolution or vertical resolution for bandwidth. The 11401/11402 give you both for making demanding voltage and timing measurements in one box. In addition, the 11401/11402's trigger-to-trigger measurement feature delivers 200-ps precision on single-shot time A→B measurements and can even provide 10-ps precision with averaging. Trigger-to-trigger measurements of this nature are only available on the 11401/11402 and a few expensive, standalone counter/timers. Also, window records can be used to increase horizontal resolution on specific segments of main records to provide a clear picture of signal details.

Multiple Long Record Lengths

The 11401/11402 can acquire multiple records of up to 10,240 points each. No other scope can capture as much data at once on repetitive waveforms. The mainframes can contain up to 102,400 points of waveform memory with Option 2D. Long records and large storage capacity combine to let users gather data over relatively long periods of time with high resolution and improve measurement accuracy. One doesn't need a computer to log waveform data. Waveforms can be stored on-board the scope for later analysis.

Versatility for a Wide Range of Applications

Five plug-ins and new probes bring outstanding versatility to the 11401/11402. The measurement-system and waveform-processing functions lead to quick solutions to a wide variety of voltage, time, area and energy problems. The 1-GHz 11402 can process and measure signals from high-bandwidth 50-Ω amplifiers, high-impedance amplifiers, and differential amplifiers. 1-mV sensitivity and 500-V maximum input voltage let users capture small signals from transducers or monitor ac power lines. Fast overdrive recovery and up to 2000 divisions of dynamic range give these scopes the power to look at even the smallest detail on difficult-to-capture waveforms.

Unparalleled Ease of Use

The 11401 and 11402 use simple parallel menus and touch screen to give easy access to their measurement and display features. All but a few of the buttons and knobs have been eliminated in favor of a system that only presents selections when they are valid and/or useful. An autoset function sets up the scope for you based upon the signal characteristics of the selected trace. This function can be activated from the probe tip, allowing for hands-off operation of the scope. Autoset frees the operator to concentrate on the measurement problem and the probe connection. The most commonly used functions are no deeper than a second menu level. Icons let you assign the knobs to waveform size and position no matter what operating mode you are in. Pop-up menus present choices and fold down when those selections are made. One-button hard-copy generation is made possible by the use of a standard Centronix port and software drivers compatible with Tektronix 4644 and low-cost Epson dot-matrix printers. Overall, the operation of the 11401/11402 is intuitive. The instrument can be used easily even if it is not used every day. Acquisition, measurement, and documentation is as simple as six touches: Auto-set, measure, measurements, rise, exit, hard copy. It doesn't get any simpler.

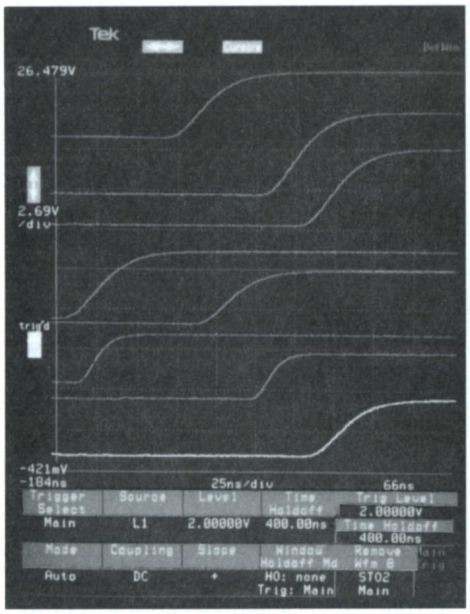
Plug-In Modularity

The 11401 and 11402 are compatible with five different vertical amplifiers. Each scope will accept three of these amplifiers in its plug-in compartments. You can configure a scope to meet your particular needs, for example:

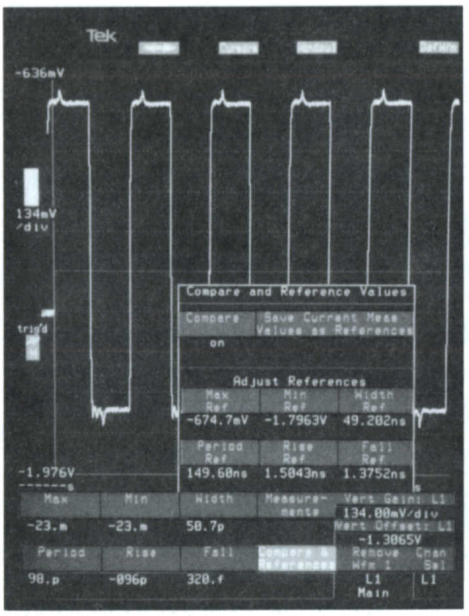
- **Timing Measurements on High-Speed Logic**
  Use three 11A71s in the 11402 for three 1-GHz bandwidth channels.
- **Characterization of Waveforms in a Lab**
  Select an 11A52 for two high-bandwidth 50-Ω channels, an 11A33 for high-bandwidth differential measurements, and an 11A34 for four high-impedance channels.
- **Prototype Troubleshooting and Debugging**
  Use two each, four-channel amplifiers and a two-channel high-bandwidth amplifier. This configuration gives you eight channels of acquisition for timing analysis and two high-bandwidth channels for exacting pulse response measurements.
- **Power-Supply Evaluation**
  Use three differential amplifiers to determine efficiency and stability and to measure noise and ripple.
- **DAC and Operational-Amplifier Settling Time**
  Fast overdrive recovery and up to 14 bits of resolution make possible settling-time measurements to within a fraction of a percent.

The Most Accurate Instruments of Their Kind

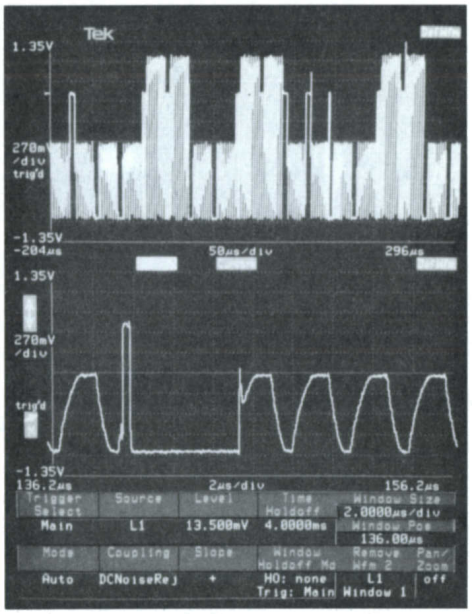
The 11401 and 11402 are the most accurate high-bandwidth scopes on the market. They combine the timing accuracy inherent in digital time bases with 1% vertical accuracy. The Enhanced Accuracy feature prompts the user to start self-calibration routines whenever temperature or configuration changes warrant it. You can even assign the 11401/11402 to start a self-calibration automatically. Time-base accuracy is



The 11401 and 11402 can display up to eight traces from a variety of sources. Display eight channels of live waveforms for timing analysis on digital systems, or display combinations of live and stored waveforms.



Multiple waveform-parameter measurements can be performed and are updated continuously. A compare-and-reference measurement mode allows measurement results to be compared to a standard, and the difference of two results to be displayed.



Two built-in time bases provide the functionality of delaying and delayed sweeps in analog scopes. The main time base defines the overall acquisition interval and the window time base allows high-resolution acquisition of small portions of complex waveforms.

100 ps +0.002% of the measured time interval. The 11401 and 11402's accurate, automatic measurements can replace dedicated counter/timers and ac voltmeters. Devices and subassemblies can be tested to tighter tolerances, improving end product performance and quality.

On-Site Serviceability

These scopes are card modular; they have extensive self-test and diagnostic routines and reliability built-in. On-site *Warranty-Plus* service options help you keep the instruments up and running when down time might otherwise halt your production line. Tektronix service technicians can be at your facility repairing these products within eight working hours if you are within 75 miles of designated U.S. service centers.

Probe Interface

We've set a new standard for probe interfacing. Signal and probe-power connections are all made at the amplifier input, eliminating extra probe-power lines. We can support as many active probes as you have channels. A smart serial interface between the probe and the scope lets you stop worrying about the proper termination impedance; it is set automatically. You can autoset the scope or sequence through a series of front-panel set-ups all from the probe-ID button. This leaves your hands free to probe your circuit. A full complement of active and passive probes with this new interface is ready to assist in the solution to your measurement problems.

Choose Your Computer Interface

The 11401 and 11402 have both IEEE-488 and RS-232C interfaces as standard features for data transfer and instrument control. The RS-232C port lets you control the instrument with a PC, upload or download waveforms from a workstation or mainframe, or run diagnostics over a modem. GPIB and RS-232C menus let you match interface parameters with a controller, modem, or host. If speed is a consideration, the parallel interface provided by the IEEE-488 port should be used. A DMA option can be added to speed up GPIB data transfers even further. Whichever bus is chosen, the instruments respond to a logical set of Tektronix *Standard Codes and Formats* commands that make it easy to write your test procedures.

Accurate, Automatic Measurements

The only reason oscilloscopes exist is for making measurements. The 11401 and 11402 perform waveform-processing functions, pulse-parameter analysis, cursor functions, and trigger-to-trigger measurements that combine to cover a full range of measurement needs. A special annotation mode shows where measurements are being made on the trace so users can feel confident that they are on target. Dot cursors can be split between two waveforms to make propagation-delay measurements or compare voltages. Measurement zones can be set to limit the automatic measurement to a portion of a displayed trace. Users can set proximal, distal, and mesial levels to customize timing measurements. Up to six measurement results can be displayed and continuously updated as the data changes. This lets users make adjustments and see the results quicker than ever before. A direct hard-copy output is provided that includes time and date of the measurement for archiving.

A Measurable Advance in Oscilloscope Technology

Higher bandwidths, better resolution, more accuracy, more versatility, hardware and software modular, easier to use and service, the 11000 Series sets new standards for digitizing oscilloscopes.

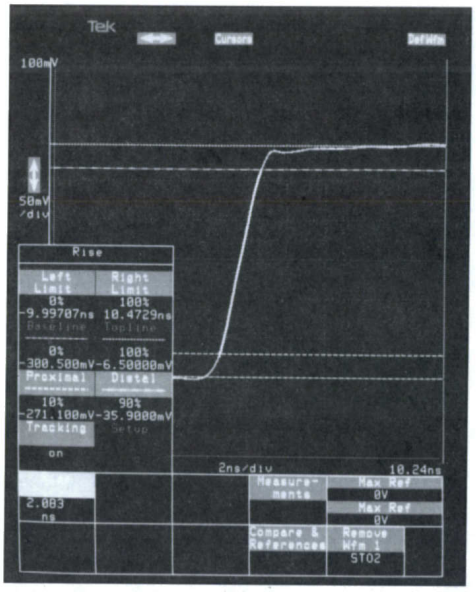
CHARACTERISTICS

VERTICAL SYSTEM

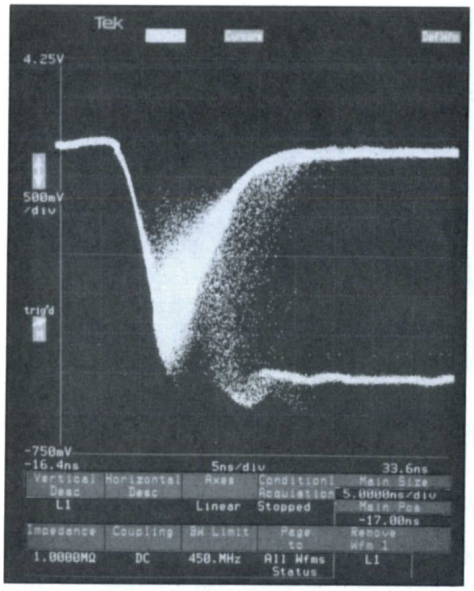
Accuracy With Enhanced Accuracy—Depends on plug-in unit.

Equivalent-Time Bandwidth—Depends on plug-in used. (See Maximum Bandwidth Matrix in the 11000-Series Reference section.)

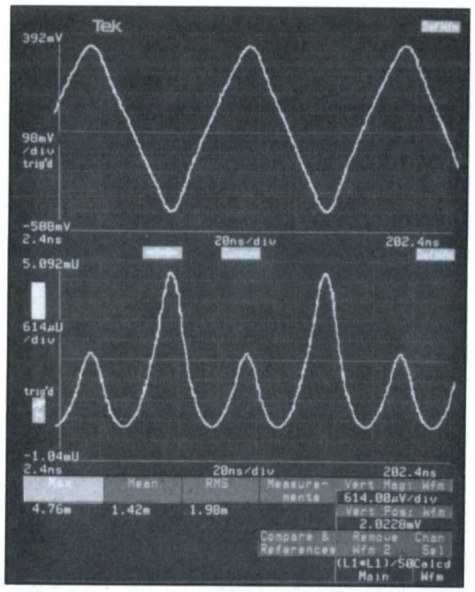
Vertical Resolution—10 bits (1024 levels.) Resolution can be increased to 14 bits (16384 levels) using signal averaging.



High bandwidth allows capture and measurement of fast rise times. Measurements can be customized and annotated to clearly show where and how the measurement is being made.



A high-resolution display with Point-Accumulate Mode along with powerful triggering makes it much easier to capture and display common digital-fault conditions like metastable states, glitches, and race conditions.



Powerful waveform-processing functions let users defne traces such as the power waveform shown above. The top waveform is a voltage waveform and the bottom waveform is a power waveform created by squaring the voltage waveform and dividing it by a load resistance.

HORIZONTAL SYSTEM

Time Bases—Two identical built-in time bases. Record Duration—5.12 ns to 1024 s in 1-2-5 sequence.

Time-Base Accuracy—100 ps +0.002% of measurement interval.

Record Length—512 points to 10,240 points.

Sampling Rate—20 MS/s maximum.

Main Record Positioning—Position of the main record with respect to the trigger point of the main record. Pretrigger: 1 record duration. Posttrigger: 1 record duration. Resolution: 1 main record point.

Windows—In addition to the main record, either one or two window records may be acquired and displayed. The window records may be of a different length (duration) and may have a smaller time/div than the main record.

If two window records are used, they have the same duration and time/div settings and can be positioned independently.

Window Record Positioning—The window records are positioned relative to a window trigger point, which may be positioned relative to the main record's trigger point delayed by either time or events.

Main→Window Time Measurement—The time between the MAIN record trigger and the WINDOW trigger can be measured precisely, even if each trigger occurs only once. Repetitive events allow this measurement to be averaged for better resolution and accuracy. Single Trigger Precision: 200 ps. Repetitive Precision: 10 ps, after 100 averages. Accuracy: 250 ps +0.002% of record duration.

TRIGGERING SYSTEM

Range—±Full screen.

Bandwidth—500 MHz maximum.

Coupling and Sensitivity—
DC Coupled: 0.35 div from dc to 50 MHz, increasing to 1 div at 500 MHz.
Noise Reject Coupled: 1.2 div or less from dc to 50 MHz, increasing to 3 div at 500 MHz.
AC Coupled: 0.35 div from 60 Hz to 50 MHz increasing to 1 div at 500 MHz. Attenuates signals below 50 Hz.

HF Reject Coupled: 0.5 div from dc to 30 kHz.

LF Reject Coupled: 0.5 div from 80 kHz to 50 MHz, increasing to 1 div at 500 MHz.

Holdoff Range—500 ns to 10 s.

MEASUREMENT SYSTEM

Waveform-Processing Functions—Waveform Functions: Differentiate, integrate, interpolate, smooth, average, and envelope. Arithmetic Operators: Plus, minus, multiply, divide, square root, logn, absolute value, signum, exp.

Measurement Set—Amplitude Measurements: Min, max, mid mean, peak-peak, RMS. Timing Measurements: Rise, fall, width, delay 1, main→window, period, propagation delay, and frequency. Area and Energy: Area +, Area −, energy. Cursors: Single or dual dots, split or paired mode, horizontal and vertical bars, measurement-zone delimiters.

CRT AND DISPLAY FEATURES

Standard CRT—9 in. diagonal, monochrome, magnetic deflection. Vertical raster-scan orientation.

Standard Phosphor—GH (P31).

Video Resolution—552 horizontal by 704 vertical displayed pixels.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 132 V RMS. 180 to 250 V RMS.

Line Frequency—48 to 440 Hz.

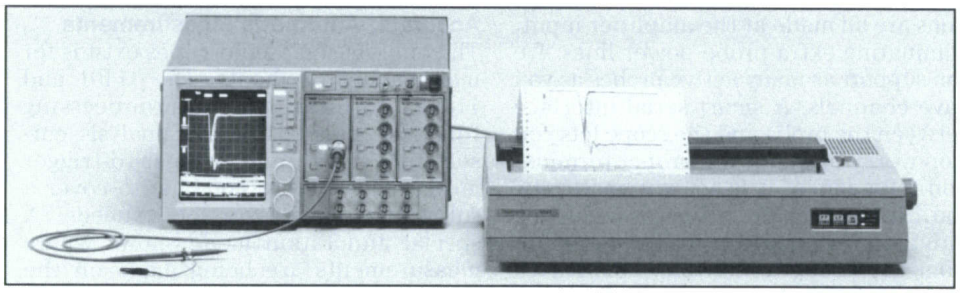
Maximum Power Consumption—320 W.

ENVIRONMENTAL AND SAFETY

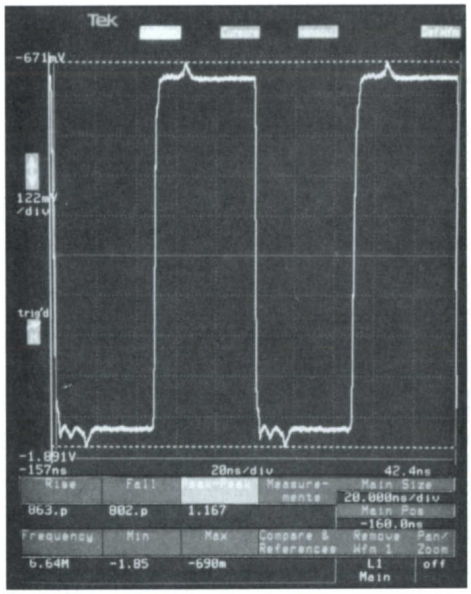
Temperature—Operating: 0 to +50°C. Nonoperating: −40 to +75°C.

Humidity—Operating and Nonoperating: Up to 95% relative humidity, up to +50°C.

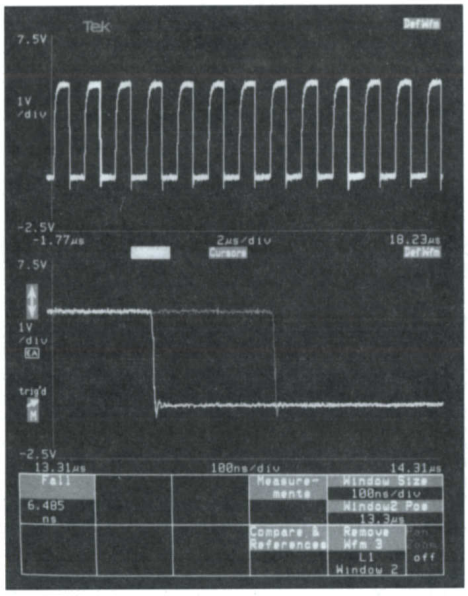
Altitude, Vibration, Shock, Bench Handling—Meets MIL-T-28800C, Type III, Class 5.



Direct hard-copy output to dot matrix printers is provided through a standard Centronics port. Hard copies are time and date stamped for archiving.



The 11401 and 11402 offer a unique combination of accurate timing and accurate amplitude measurements in one instrument.



Single or dual 10×10-division axes may be brought up for waveform display. Each axis represents a full 10-bit digitizing window.

The 11401 and 11402 are easily integrated into automated test systems. Options for rack conversion, rear-to-front signal routing, and DMA transfer of waveform data and measurement results make the 11401/11402 ideal for systems applications.

Electromagnetic Compatibility—Meets MIL-T-28800C; MIL-STD-461B; FCC Part 15, Subpart J, Class B; VDE 0871/6.78 Class B; CE-01 Part 4, with exceptions; CE-03 Part 4, Curve 1; CE-03 Part 4, Curve 4, Navy, NB, BB (with exceptions); CS-01 Part 7; CS-02 Part 4 (with exceptions); CS-06 Part 5; RE-01 Part 4 (with exceptions); RE-02 Part 4; RS-01 Part 4; RS-03 Part 7 (limited to 1 GHz).
Safety—Listed UL 1244; CSA Bulletin 556B, September 1973; Tektronix self-certification to comply with IEC 348 recommendations.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	448	17.6	483	19.0
Height	238	9.4	222	8.8
Depth	599	23.6	550	21.6
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	19	41.6	22.0	48.0
Shipping	28.0	62.0	31.4	68.0

ORDERING INFORMATION

11401 500-MHz Programmable Digitizing Oscilloscope **$13,000**
Includes: Operator guide (070-6103-00); operator reference (070-5791-00); power cord (161-0066-00); incoming inspection procedure (070-6694-00).
11402 1-GHz Programmable Digitizing Oscilloscope **$15,500**
Includes: Same as 11401.

OPTIONS

Option 1C—Cable Feedthroughs. Adds eight rear-to-front feedthroughs. **+$200**
Option 1R—Rackmount. **+$250**
Includes: Hardware, tooling, and instructions for converting bench model to rackmount configuration.
Option 2D—Memory Expansion. Expands total waveform memory to 102,400 points for storage of waveform records. **+$600**
Option 4D—DMA Controller. Increases data transfer speed over GPIB. **+$400**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 250 V, 60 Hz.
Option A5—Switzerland 240 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Customer Services and Information section in the back of this catalog.
S0—On-Site Product Installation and Set-Up. **+$475**
S1—(11401) 1 Year On-Site Service. **+$380**
S1—(11402) 1 Year On-Site Service. **+$410**

OPTIONAL ACCESSORIES

Power-Supply Extended Diagnostics. Order 067-1264-00 **$320**
Service Manual—Order 070-6779-00*1
Camera—C-4 Option 10 **$409**
Cables—
(GPIB) 2 m. Order 012-0991-00 **$155**
(RS-232C) 10 ft. Order 012-0911-00 **$100**
(Centronics) 10 ft for hard copy output. Order 012-0555-00 **$120**
Blank Panel—For empty compartments. Order 016-0829-00 **$95**
Extender Board—
Order 067-1267-00.*1
Hard Copy Unit—Tektronix 4644 Dot Matrix Printer **$695**
Recommended Probes—See recommended probes later in this section.
Recommended Cart—K217. See Instrument/Cart Compatibility chart in the Accessories section. **$510**

*1 *To order, contact your local Tektronix Sales Office.*

SOFTWARE SUPPORT

11400-Series/IBM PC Utility—Waveform/measurement data logging, graphics, and statistical analysis. GPIB and RS-232C support. Order S47P102. **$450**
11400-Series Asyst Driver—Menu-driven package for scope control, waveform acquisition, data logging, and FFT analysis. Order S47P303 **$395**
For more information on utility and application software, see System Support section or consult your local sales or applications engineer.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. See Customer Training section for information or call 1-800-835-9433 ext. 430. In Oregon, call 1-629-1017 (collect).

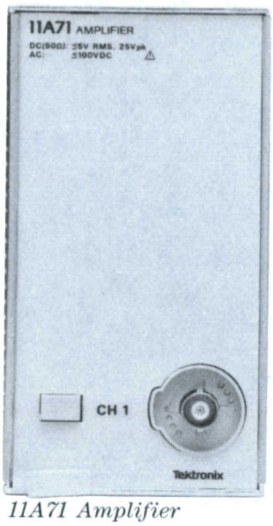
11000 -Series Plug-Ins

- **Single Trace (11A71)**
- **Dual Trace (11A32, 11A52)**
- **Differential (11A33)**
- **Four Channel (11A34)**
- **Up to 500-MHz Bandwidth (With 11302)**
- **Up to 1-GHz Bandwidth (With 11402)**
- **1-mV/Div Deflection Factor**
- **Calibrated Offset With Fast Overdrive Recovery**
- **Switchable Input Impedances**

Wide bandwidth, unsurpassed accuracy, clean response, low noise, and calibrated dc offset with fast overdrive recovery characterize the amplifier plug-in units available for use with the Tektronix 11000-Series oscilloscopes. The 11A71 provides 1-GHz bandwidth in the 11402 digitizing mainframe and up to 500-MHz bandwidth in the 11302 analog mainframe. The 11000-Series Maximum Bandwidth Matrix at the start of this section shows the bandwidth of each of the amplifier plug-in units in each of the four 11000-Series mainframes.

Control of the 11000-Series plug-ins is accomplished through the mainframe controls, either manually or over the IEEE-488 or RS-232C bus. The only control on the amplifier plug-ins is a single pushbutton for each channel. This button is used only to turn the display of the associated channel on and off; it has no effect on the availability of the input signal to the triggering system.

Each of the input channels on all amplifier plug-ins uses the new TEKPROBE™ interface. This interface allows the mainframe to supply power to active probes, to sense the type (and, with some probes, the serial number) of the probe, to supply offset voltage to probes so equipped, to detect activation of the probe's ID pushbutton, and to provide other communication between probe and oscilloscope as appropriate to the type of probe. A serial data line in the TEKPROBE™ interface provides the means for a high level of communication with current and future special-purpose probes.



11A71 Amplifier

11A71

- **DC to 1 GHz Bandwidth (in 11402)**
- **Single Trace**
- **10-mV to 1-V/Div Calibrated Deflection Factors**
- **±10-Div Offset**
- **50-Ω Input Impedance**

The single-channel 11A71 is the highest bandwidth amplifier currently available for the Tektronix 11000-Series mainframes. It provides 1-GHz bandwidth in the 11402 digitizing mainframe and 500-MHz bandwidth in the 11302 analog mainframe.

DC offset can be set to 40 steps per division over a range of ±10 div at all sensitivities.

CHARACTERISTICS

Number of Channels—One.

Bandwidth—All Deflection Factors

11301	11302	11401	11402
400 MHz	500 MHz	500 MHz	1 GHz

Deflection Factor—10 mV to 1 V/div in 1-2-5 sequence.

Accuracy—
ΔVolts dc accuracy:
With 11301/11302: ±(0.9% +0.05 div).
With 11401/11402: ±(0.7% +0.03 div).
DC Balance: ±0.2 div.

Input Impedance—50 Ω ±2%; VSWR <1.45:1, dc to 1 GHz.

Input Coupling Modes—AC, DC, off.

Offset Range—±10 divisions, 0.025 division resolution, all deflection factors.

Max Input Voltage—50-Ω input automatically disconnects when the signal exceeds safe limits. Manual reset.

Typical Noise (RMS)—0.01 div.

ORDERING INFORMATION

11A71 Single-Channel Vertical Amplifier **$2,700**
Includes: Operator manual supplement.
Option 26—Includes one P6231 probe.*1

OPTIONAL ACCESSORIES

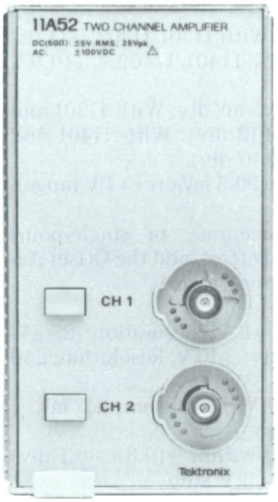
Service Manual—
Order 070-6787-00*1
Recommended Probe—P6231 10X 1.5 GHz active probe. See other recommended probes later in this section. **$410**

Optical to Electrical Converters—
P6701 **$1,800**
P6702 **$1,995**

Spatial Input Head—
P6751 **$295**

See Accessories section for complete description.

*1 *To order, contact your local Tektronix Sales Office.*



11A52 Two-Channel Amplifier

11A52

- **DC to 600-MHz Bandwidth (in 11402)**
- **Dual Trace**
- **1-mV to 10-V/Div Calibrated Deflection Factors in 1% Increments**
- **50-Ω Input Impedance**
- **High-Resolution Calibrated DC Offset**
- **Fast Overdrive Recovery**

The 11A52 is the highest bandwidth dual-trace amplifier plug-in currently available for the 11000-Series mainframes.

The 11A52 provides 600-MHz bandwidth in the 11402 digitizing mainframe and 400-MHz bandwidth in the 11302 analog mainframe. Two built-in four-pole bandwidth-limiting filters (100 and 20 MHz) may be activated to reduce unwanted high-frequency noise at 24 dB/octave.

Both coarse and fine deflection-factor steps are fully calibrated. At 1 mV/div, the high-resolution calibrated dc offset has a setability of 25 μV and a range of ±1 V (equivalent to 16 bits), giving an effective screen height of 2000 divisions and permitting absolute dc measurement accuracies to ±0.3%.

CHARACTERISTICS

Number of Channels—Two.

Bandwidth (MHz)

Volts/div	11301	11302	11401	11402
>10 mV	350	400	500	600
5 to 9.95 mV	300	350	350	400
2 to 4.98 mV	250	250	250	250
1 to 1.99 mV	200	200	200	200

Calibrated Deflection Factors—Coarse: 1 mV to 10 V/div in 1-2-5 steps. Fine: between coarse steps in 1% increments of next more sensitive coarse step.

Accuracy—
ΔVolts dc accuracy:
With 11301/11302: ±(1.0% + 0.04 div).
With 11401/11402: ±(0.8% + 0.01 div).
DC Balance, 1 to 99.5 mV/div: With 11301 and 11302: ±(0.2 mV + 0.13 div). With 11401 and 11402: ±(0.2 mV + 0.10 div).
Offset Accuracy, 1 to 99.5 mV/div (±1 V range): ±(0.15% + 0.4 mV).
For absolute dc accuracy of single-point measurements using offset, add the Offset Accuracy and DC Balance terms.

Offset Range—
1 to 99.5 mV/div: ±1 V; Resolution: 25 μV. 100 mV to 0.995 V/div: ±10 V; Resolution: 250 μV. 1 to 10 V/div: ±100 V; Resolution: 2.5 mV.

Overdrive Recovery—1 to 99.5 mV/div: To within ±(0.2% + 0.1 div) within 20 ns from ±2 V step.

Typical Noise (RMS)—
1 to 1.99 mV/div: 0.087 div.
2 to 4.98 mV/div: 0.04 div.
5 to 9.95 mV/div: 0.02 div.
10 mV to 10 V/div: 0.012 div.

Input Impedance—50 Ω ±0.5%; VSWR: <1.3:1 dc to 500 MHz.

Input Coupling Modes—AC, DC, and off.

Maximum Input Voltage—Input automatically disconnects when the input signal exceeds safe limits. Manual reset.

ORDERING INFORMATION

11A52 Two-Channel Vertical Amplifier **$2,405**
Includes: Operator manual supplement.

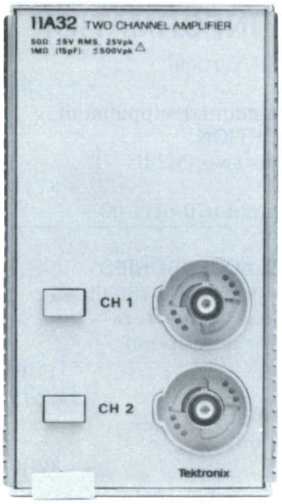
OPTION

Option 25—Includes two P6231 probes. **+$740**
Includes: User manual 070-6114-00.

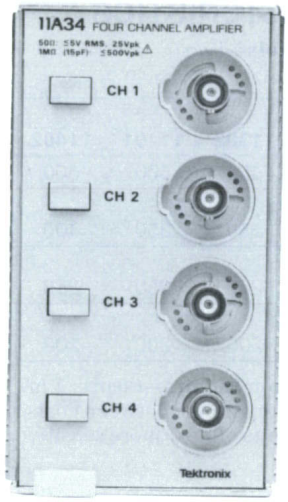
OPTIONAL ACCESSORIES

Service Manual—Order 070-6786-00*[1]
Optical to Electrical Converters—
See Probe section for description.
P6701 **$1,800**
P6702 **$1,995**
Spatial Input Head—See Probe section for description.
P6751 **$295**

*[1] *To order, contact your local Tektronix Sales Office.*



11A32 Two-Channel Amplifier



11A34 Four-Channel Amplifier

11A32/11A34

- **DC to 350-MHz Bandwidth (11A32 in 11402 Mainframe)**
- **Dual Trace (11A32) or Four Trace (11A34)**
- **1-mV to 10-V/Div Calibrated Deflection Factors in 1% Increments**
- **Switchable 50-Ω or 1-MΩ Input Impedance**
- **High-Resolution Calibrated DC Offset**
- **Fast Overdrive Recovery**

The 11A32 and 11A34 amplifier plug-in units are virtually identical to one another except for the number of channels. The 11A32 is a dual-trace unit, and the 11A34 is a four-trace unit. The bandwidth of the 11A32 is slightly higher than that of the 11A34 in each of the four 11000-Series mainframes.

Two built-in four-pole bandwidth-limit filters (100 and 20 MHz) may be activated to reduce unwanted high-frequency noise at 24 dB/octave for each channel.

Both coarse and fine deflection-factor steps are fully calibrated. At 1 mV/div, the high-resolution calibrated dc offset has a setability of 25 μV and a range of ±1 V (equivalent to 16 bits), giving an effective screen height of 2000 div and permitting absolute dc measurement accuracies to ±0.4%.

CHARACTERISTICS

Number of Channels—11A32: Two; 11A34: Four.

Calibrated Deflection Factors—Coarse steps: 1 mV to 10 V/div in 1-2-5 sequence. Fine steps: Between coarse steps in 1% increments of next more-sensitive coarse step.

Accuracy—
ΔVolts dc accuracy: With 11301/11302: ±(1.0% +0.04 div). With 11401/11402: ±(0.9% +0.012 div).
DC Balance, 1 to 99.5 mV/div: With 11301 and 11302: ±(1.0 mV+0.13 div). With 11401 and 11402: ±(1.0 mV+0.10 div).
Offset Accuracy, 1 to 99.5 mV/div (±1 V range): ±(0.2%+0.5 mV).
For absolute dc accuracy of single-point measurements using offset, add the Offset Accuracy and DC Balance terms.

Offset Range—
1 to 99.5 mV/div: ±1 V; Resolution: 25 μV.
100 mV to 0.995 V/div: ±10 V; Resolution: 250 μV.
1 to 10 V/div: ±100 V; Resolution: 2.5 mV.

Overdrive Recovery—
1 to 99.5 mV/div: To within ±(0.3%+0.1 div) within 50 ns from ±2 V step.
100 to 995 mV/div: To within ±1% within 50 ns from ± 20 V step.
1 to 10 V/div: To within ±1% within 50 ns from ±200 V step.

Typical Noise (RMS)—
1 to 1.99 mV/div: 0.12 div.
2 to 4.98 mV/div: 0.06 div.
4 to 9.95 mV/div: 0.025 div.
10 mV to 10 V/div: 0.014 div.

Input Impedance—Switchable 1 MΩ in parallel with 15 pF, or 50 Ω ±0.5%.

Input Coupling Modes—AC, DC, and off.

Maximum Input Voltage—1 MΩ: 500 V (dc + peak ac). 50 Ω: Input automatically disconnects when the input signal exceeds safe limits. Manual reset.

Bandwidth—11A32

Volts/div	11301	11302	11401	11402
>10 mV	300 MHz	350 MHz	350 MHz	400 MHz
5 to 9.95 mV	250 MHz	250 MHz	300 MHz	350 MHz
2 to 4.98 mV	200 MHz	200 MHz	250 MHz	250 MHz
1 to 1.99 mV	200 MHz	200 MHz	200 MHz	200 MHz

Bandwidth—11A34

Volts/div	11301	11302	11401	11402
>10 mV	250 MHz	250 MHz	300 MHz	300 MHz
5 to 9.95 mV	200 MHz	250 MHz	250 MHz	250 MHz
2 to 4.98 mV	200 MHz	200 MHz	200 MHz	200 MHz
1 to 1.99 mV	150 MHz	150 MHz	150 MHz	150 MHz

ORDERING INFORMATION

11A32 Two-Channel Vertical Amplifier — **$2,025**
Includes: Operator manual supplement.

11A34 Four-Channel Vertical Amplifier — **$3,525**
Includes: Operator manual supplement.

OPTIONS

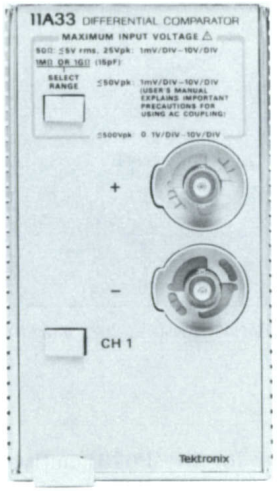
Option 22—(11A32) Includes two P6134 probes. — **+$305**

Option 23—(11A34) Includes four P6134 probes. — **+$610**

OPTIONAL ACCESSORY

Service Manual—
(11A32) Order 070-6782-00*1
(11A34) Order 070-6785-00*1

*1 *To order, contact your local Tektronix Sales Office.*



11A33 Differential Comparator

11A33

- **Differential Comparator**
- **DC to 150-MHz Bandwidth**
- **1-mV to 10-V/Div Calibrated Deflection Factors in 1% Increments**
- **Very-High-Resolution Calibrated DC Offset**
- **16000-Division Effective Screen Height**
- **High Common-Mode Rejection**
- **Fast Overdrive Recovery From Large Input Signals**
- **Selectable 50-Ω, 1-MΩ, or 1-GΩ Input Impedance**

The 11A33 Differential Comparator plug-in is a single-channel differential amplifier with high common-mode-rejection ratio and fast overdrive recovery from very large signals. As a differential amplifier, common-mode input-voltage range is ±8 V at 1 mV/div. As a comparator, the built-in comparison voltage (Vc) is used to measure the fine structure of very large signals, such as the settling time of a digital-to-analog converter, with unprecedented accuracy and resolution.

Maximum bandwidth in the 11301, 11302, 11401, and 11402 mainframes is 150 MHz. Two built-in four-pole bandwidth-limit filters (100 and 20 MHz) may be activated to reduce unwanted high-frequency noise at 24 dB/octave for each channel.

Both coarse and fine deflection factors are fully calibrated. At 1 mV/div, the high-resolution comparison voltage has a setability of 25 μV throughout its ±8 V range (equivalent to 19 bits), giving an effective screen height of 16,000 div and permitting absolute dc measurement accuracies of ±0.2%.

CHARACTERISTICS

Number of Channels—One.
Bandwidth—DC to 150 MHz in 11301, 11302, 11401, and 11402 mainframes. (DC to 120 MHz at 1 mV/div.)
Calibrated Deflection Factors—Coarse steps: 1 mV to 10 V/div in 1-2-5 sequence. Fine steps: Between coarse steps in 1% increments of next more-sensitive coarse step.
Accuracy—ΔVolts dc accuracy: With 11301/11302: ±(1.0% + 0.04 div). With 11401/11402: ±(0.9% + 0.01 div).
DC Balance, 1 to 99.5 mV/div: With 11301 and 11302: ±(0.5 mV + 0.13 div). With 11401 and 11402: ±(0.5 mV + 0.10 div).
Vc Accuracy, 1 to 99.5 mV/div (8 V range): ±(0.15% + 0.6 mV).
For absolute dc accuracy of single point measurements using Vc, add the Vc Accuracy and dc balance terms.
Vc Range—
1 to 99.5 mV/div: ±8 V; Resolution: 25 μV.
100 mV to 0.995 V/div: ±80 V; Resolution: 250 μV. 1 to 10 V/div: ±500 V; Resolution: 2.5 mV.
Overdrive Recovery—1 to 99.5 mV/div: To within ±0.25% within 40 ns from ±8 V step, slew rate less than 1 V/ns.
Typical Noise (RMS)—
1 to 1.99 mV: 0.24 div.
2 to 4.98 mV: 0.12 div.
5 to 9.95 mV/div: 0.05 div.
10 mV to 10 V/div: 0.03 div.
Common-Mode-Rejection Ratio—1 to 99.5 mV/div: 10,000:1 dc to 1 MHz; 2000:1 at 5 MHz (8 V p-p signal).
100 mV to 0.995 V/div: 1000:1 dc to 1 MHz; 100:1 at 10 to 20 MHz (30 V p-p signal).
1 to 10 V/div: 500:1 dc to 250 kHz (100 V p-p signal).
Input Impedance—50 Ω, 1 MΩ in parallel with 15 pF, or 1 GΩ in parallel with 15 pF from 1 to 99.5 mV/div.
Input Coupling Modes—AC, DC, and off (each input).
Max Input Voltage—1-MΩ mode: 1 to 99.5 mV/div: 40 V (dc + peak ac); 100 mV to 0.995 V/div: 400 V (dc + peak ac); 1 to 10 V/div: 500 V (dc + peak ac). (At 1 to 99.5 mV/div, derate max input voltage at 20 dB/decade above 3 MHz; at 100 mV to 10 V/div, derate max input voltage at 20 dB/decade above 1 MHz.)
50 Ω: Input automatically disconnects when the input signal exceeds safe limits. Manual reset.

ORDERING INFORMATION

11A33 Differential Comparator **$3,000**
Includes: Operator manual supplement.

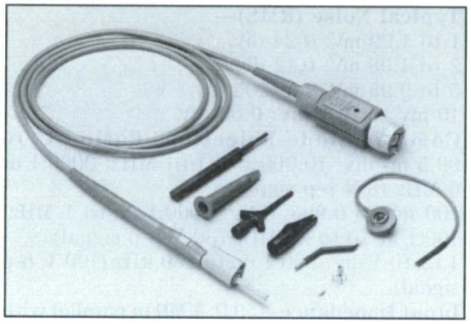
OPTION

Option 24—Includes a P6135 probe pair. **+$395**

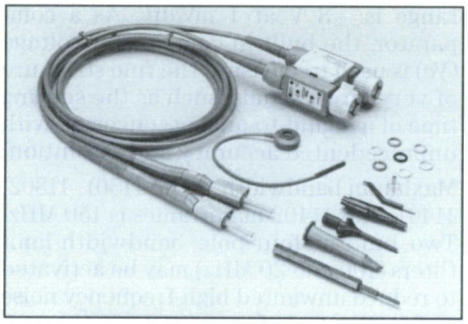
OPTIONAL ACCESSORY

Service Manual—Order 070-6784-00*[1]

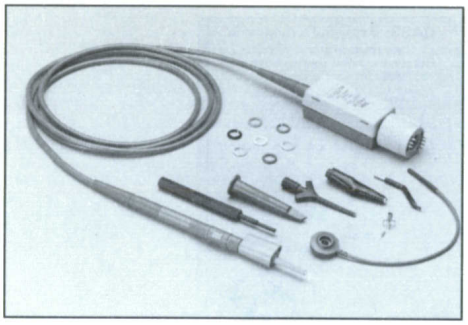
*[1] *To order, contact your local Tektronix Sales Office.*



P6134 10X, 10-MΩ Passive Probe (shown with typical accessories).



P6135 10X, Matched Pair of 1-MΩ Differential Passive Probes (shown with typical accessories).



P6231 10X, 450-Ω Active Probe (shown with typical accessories).

P6134 10X, 10-MΩ Passive Probe

P6135 10X, Matched Pair of 1-MΩ Differential Passive Probes

P6231 10X, 450-Ω Active Probe

Three high-performance probes round out the capabilities of the 11000-Series oscilloscopes and plug-ins.

The P6134 is a 10X passive probe that is intended primarily for use with the 11A32 and 11A34, with their 1-MΩ input impedances. The P6135 is actually a matched pair of probes clipped together at the scope input end. The P6135 has attenuation adjustments to match the attenuation of the two halves to provide high common-mode rejection compatible with the 11A33 Differential Comparator plug-in.

The P6231 is a 1.5-GHz, low-impedance, subminiature, 10X active probe intended primarily for use with high-speed logic circuits. The P6231 provides a "nulling voltage," adjustable via the mainframe controls over a ±5-V range. This nulling voltage reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage is other than zero, or in circuits where the termination resistance is returned to other than ground level.

The 50-Ω termination required by the P6231 at the plug-in input is automatically accommodated by the 11000-Series mainframe. When a P6231 is connected to an input connector of an 11A32, 11A33, or 11A34 Amplifier plug-in unit, the plug-in input impedance is automatically switched to 50 Ω. The 11A52 and 11A71 Amplifier plug-ins have fixed 50-Ω input impedances.

Each of the three probes has an "ID" button which, when pressed, will cause any one or more of several actions to be taken by the mainframe—autoset, recall the next in a series of stored setups, invoke the automatic-measurement function, or issue an SRQ. These actions are selectable via the mainframe UTILITY major menu.

All of the 11000-Series probes make use of the probe interface of the 11000-Series plug-ins. Each of the probes communicates its attenuation ratio to the mainframe. Power for the P6231 active probe comes through that interface, eliminating the need for a special power cable or power source. The bias voltage for the P6231 is applied through that interface. The P6231 also communicates its type and serial number through the serial-data communication lines in the interface connector. Sensing of the pressing of the ID buttons on the probes is done through the interface.

All of the probes are compatible with the subminiature accessories shown in the Accessories section, including the KLIPKIT.

Other voltage probes described in this catalog (that can be compensated to 1 MΩ and 15 pF or to 50 Ω) can be used with the 11000-Series plug-in units, including the operation of the ID button on probes so equipped. Refer to the Accessories section for compatibility and full descriptions of all available Tektronix signal probes and other accessories.

7000-SERIES INSTRUMENTS

CONTENTS

Reference 243
Nonstorage Mainframes 248
CRT-Storage Mainframes 258
Plug-Ins 264
Sampling 278
Digitizers 353

The 7000 Series. . .

Superior Performance

The 7000-Series plug-in laboratory instruments embody more state-of-the art performance features than any other oscilloscope-based measurement system. The 7104 and R7103 Oscilloscopes feature a 1-GHz bandwidth combined with the fastest rise time and highest photographic writing speed available today.

Maximum Flexibility

A choice of over 40 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual needs. When your needs change, your present package can be reconfigured with minimum additional equipment and effort.

Expandability

Expandability ensures that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Tektronix' most recent developments in plug-in scope capability are: the Waveform Processing Oscilloscope, the 1-GHz High-Writing-Rate Oscilloscope, the Programmable Digitizer Plug-In Unit, and the four-channel Logic-Triggered Vertical Amplifier.

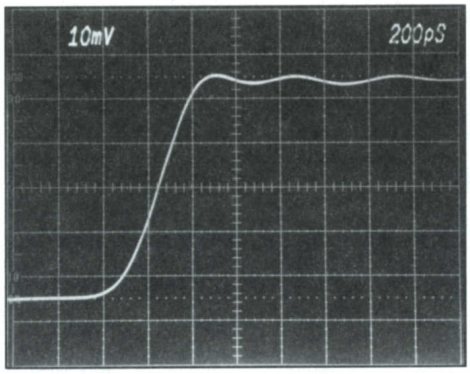
Digital-Storage Capability

The 7854 provides digital storage, pre- and post-trigger viewing, equivalent-time sampling, and waveform processing. The IEEE Standard 488 interface is standard.

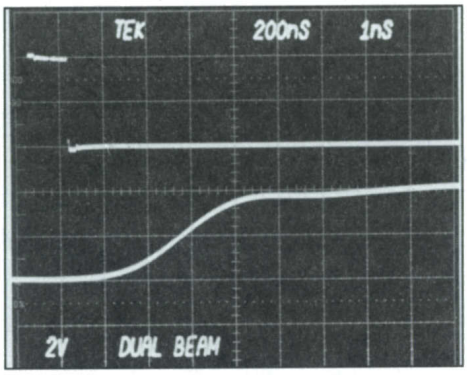
The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix commitment to bringing the ultimate in measurement technology to the laboratory.

400-MHz Dual Beam

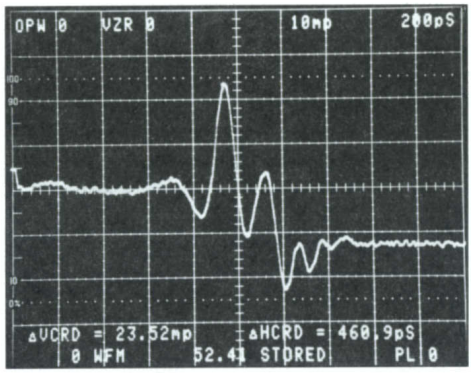
A dual-beam oscilloscope is essentially two oscilloscopes in one. A dual-beam



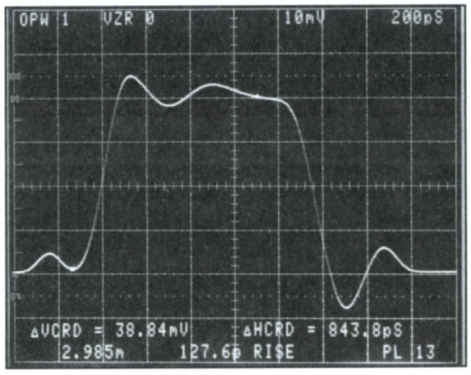
Nonstorage 1-GHz 7104/R7103. This 300-ps rise time is displayed on a 7104 Oscilloscope. Readout indicates 10-mV/div vertical sensitivity and 200-ps/div sweep speed. The 7104 and R7103 provide ultra-bright displays that permit the viewing of a single-shot transient event up to the maximum bandwidth of the oscilloscope (1 GHz) in ambient light.



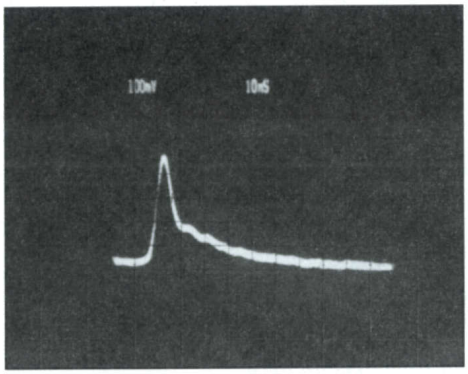
Dual-Beam 7844/R7844. The 400-MHz 7844 Dual-Beam Oscilloscope displays one input signal at two sweep speeds. The 7844 provides full vertical and horizontal crossover switching and full overlap of both vertical amplifiers on its 8×10 cm display.



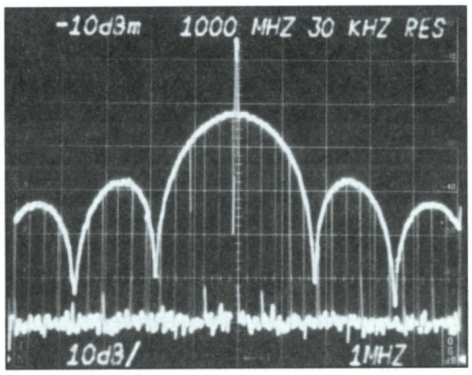
Sampling/Time-Domain Reflectometry. 7854 Waveform-Processing Oscilloscope with 7S12 TDR/ Sampling plug-in provides time-domain reflectometry and digital processing of sampling. In this photo, the 7854/7S12 measures a discontinuity in millirho/division and calculates an impedance of 52.41 Ω at the discontinuity.



Digital-Storage 7854. Here, the 7854 measures the 127.6-ps rise time of a 38.83-mV pulse displayed at a sweep speed of 200 ps/div.



Analog-Storage, 500-MHz 7934. Transient Capture—A 7A29 plug-in and the 7934's Fast Variable-Persistence storage mode in reduced scan capture a single-shot electrostatic discharge.



Spectrum Analysis. Max Hold feature of the 7L14 Spectrum Analyzer plug-in in a 7000-Series mainframe produces perfectly proportioned Sin x/x spectrum of low-rep-rate burst of 2.66 MHz, 6.67 μs in width.

oscilloscope is required in applications where two transient events must be compared simultaneously. These application areas commonly include the observation of simultaneous stimulation and reaction in such fields as radar, medicine, biology, chemistry, and mechanical engineering.

Sampling

The 7000-Series sampling plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get a low-cost storage CRT for slow scans, a random mode that lets you see leading edges without pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional display at the same time on the CRT.

CRT Storage

Five 7000-Series mainframes provide some combination of bistable and/or variable-persistence storage. The 7934 Storage Oscilloscope can capture single-shot transient events of <700-ps rise time. Variable persistence is valuable for effective viewing of slowly changing events or signals.

Digital Storage

The 7854 Waveform-Processing Oscilloscope stores repetitive signals up to 400 MHz with conventional plug-ins or up to 14 GHz with the 7S12 TDR/Sampling plug-in. The 7854 provides digital storage with waveform processing, waveform measurements at the touch of a button, keystroke programming, and a GPIB interface. The 7D20 Programmable Digitizer plug-in provides dual-trace digital storage of signals up to 70 MHz in any 7000-Series mainframe, except the 7104 and R7103.

Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 2.5 GHz is provided by the 7L5, 7L12, and 7L14 Spectrum Analyzer plug-ins. Stable, sensitive, and spurious-free, these analyzers work in any 7000-Series mainframe.

Refer to the Spectrum Analyzer section for more information.

7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

Plug-in		7A13	7A18A	7A19	7A22	7A24	7A26	7A29	7A42	7F10
Features		Differential dc offset, high-freq CMRR amplifier	Dual-channel amplifier	Wide bandwidth 50-Ω input amplifier	DC-coupled high-gain differential amplifier	Dual-channel 50-Ω amplifier	Dual-channel amplifier	Widest bandwidth single channel	Four-channel logic triggered	Optical/Electrical converter w/built-in amplifier
Minimum Deflection Factor		1 mV/div	5 mV/div	10 mV/div	10 μV/div	5 mV/div	5 mV/div	10 mV/div	20 mV/div	2 μW/div
Accuracy*1 Without Probe		1.5%	2%	2%	3%	2%	2%	2%	3%	—
7104										
R7103	BW	105 MHz	75 MHz	600 MHz	1 MHz ±10%	400 MHz	200 MHz	1000 MHz	350 MHz	750 MHz
0 to 35°C	T_r	3.4 ns	4.7 ns	0.6 ns	350 ns ±9%	0.9 ns	1.8 ns	0.35 ns	1.0 ns	
7904A										
R7903	BW	105 MHz	75 MHz	500 MHz	1 MHz ±10%	350 MHz	200 MHz	500 MHz	300 MHz	400 MHz
7934	T_r	3.4 ns	4.7 ns	0.8 ns	350 ns ±9%	1.0 ns	1.8 ns	0.7 ns*5	1.2 ns	
0 to 30°C	SIG OUT	100 MHz	90 MHz	300 MHz	1 MHz ±9%	140 MHz	140 MHz	300 MHz	NA	300 MHz
7912HB*4	BW	105 MHz	75 MHz	500 MHz	1 MHz ±10%	350 MHz	200 MHz	700 MHz	300 MHz	400 MHz
0 to 30°C	T_r	3.4 ns	4.7 ns	0.8 ns	350 ns ±9%	1.0 ns	1.8 ns	0.525 ns	1.2 ns	
7844/R	BW	100 MHz	75 MHz	400 MHz*2	1 MHz ±10%	300 MHz	180 MHz	400 MHz	275 MHz	300 MHz
0 to 35°C	T_r	3.5 ns	4.7 ns	0.9 ns	350 ns ±9%	1.2 ns	1.9 ns	0.9 ns	1.3 ns	
7854*3	BW	100 MHz	75 MHz	400 MHz*2	1 MHz ±10%	300 MHz	180 MHz	400 MHz	275 MHz	300 MHz
0 to 35°C	T_r	3.5 ns	4.7 ns	0.9 ns	350 ns ±9%	1.2 ns	1.9 ns	0.9 ns	1.3 ns	
7603/R	BW	75 MHz	75 MHz	100 MHz	1 MHz ±10%	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz
	T_r	4.8 ns	4.7 ns	3.5 ns	350 ns ±9%	3.5 ns	3.5 ns	3.5 ns	3.5 ns	
0 to 50°C	SIG OUT	55 MHz	50 MHz	65 MHz	1 MHz ±10%	60 MHz	60 MHz	65 MHz	NA	65 MHz
7633/R	BW	75 MHz	75 MHz	100 MHz	1 MHz ±10%	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz
7623A/R	T_r	4.8 ns	4.7 ns	3.5 ns	350 ns ±9%	3.5 ns	3.5 ns	3.5 ns	3.5 ns	
0 to 50°C	SIG OUT	55 MHz	50 MHz	65 MHz	1 MHz ±10%	60 MHz	60 MHz	65 MHz	NA	65 MHz
	BW									
7612D	T_r	65 MHz	65 MHz	80 MHz	1 MHz ±10%	80 MHz	80 MHz	80 MHz	80 MHz	80 MHz
0 to 40°C	SIG OUT	6.0 ns	6.0 ns	5.0 ns	350 ns ±9%	5.0 ns	5.0 ns	5.0 ns	5.0 ns	
Price		$3,655	$1,620	$3,010	$1,855	$2,760	$2,470	$3,540	$5,415	$7,250

*1 *Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%*

*2 *Bandwidth is 325 MHz at 10 mV/div.*

*3 *Bandwidth with equivalent time sampling and time display only.*

*4 *Fully programmable mainframe. 7A29P Programmable Amplifier recommended for 750-MHz bandwidth.*

*5 *R7903 with 7A29 T_r is 0.8 ns.*

7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION GUIDE*1
(All bandwidths given in MHz.)

This selection guide lists the most popular combinations for optimum performance, but is not all inclusive. Current probes and other compatible probes are listed in the Probes section.

		Passive 1-MΩ Input								Passive 50-Ω Input		Active 50-Ω/1-MΩ Inputs			
Probe		P6101A 1 m	P6105A 2 m	P6130 1.5 m P6106A 1 m	P6131 1.3 m	P6055*2 3.5 ft	P6062B*5 6 ft	P6009 9 ft	P6015 10 ft	P6056 1.5 m	P6057 6 ft	P6201*4 6 ft	P6202A*4 2 m	P6230*4 1.5 m	P6046 6 ft
7100 Family	7A19	NC	NC	NC	NC	NC	NC	NC	NC	500	480	430	300	480	100
	7A24	NC	NC	NC	NC	NC	NC	NC	NC	350	350	310	300	350	100
	7A26	34	100	175	NC			125	75			195	185	200	90
	7A29	NC	NC	NC	NC	NC	NC	NC	NC	950	800	660	450	800	100
	7A42	34	100	250	300			130	80	350	350	300	280	350	100
7900 Family	7A13	34	75	105	NC	65		85		65		105	105	105	70
	7A18A	34	75	75	NC		75	70	60		75	75	75	75	60
	7A19	NC	NC	NC	NC	NC	NC	NC	NC	500	480	430	300	480	95
	7A22	1	NC	NC	NC	1	1								
	7A24	NC	NC	NC	NC	NC	NC	NC	NC	350	350	310	290	350	90
	7A26	34	100	175	NC			125	75			185	185	290	85
	7A42	34	100	250	300			130	80	300	300	300	300	300	90
7800 Family	7A13	34	100	100	NC	65		85	60			100	100	100	70
	7A18A	34	85	85	NC		85	80	60			90	75	90	65
	7A19	NC	NC	NC	NC	NC	NC	NC	NC	400	400	360	320	400	95
	7A22	1	1	NC	NC	1	1	1	1						
	7A24	NC	NC	NC	NC	NC	NC	NC	NC	300	300	280	270	300	90
	7A26	34	100	145	NC			105	75			155	150	180	85
	7A42	34	100	200	275			110	75	275	275	260	260	275	90
7600 Family	7A13	34	70	75	NC	55	70	60	55			75	75	75	55
	7A18A	34	70	70	NC		70	65	55			75	75	75	55
	7A22	1	1	NC	NC	1	1								
	7A26	34	95	95	NC		95	85	65			100	100	100	70
	7A42	34	95	95	100		95	85	65			100	100	100	70

*1 *The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.*

*2 *Matched pair recommended.*

*3 *Option 09 Mainframe.*

*4 *Requires 1101/1101A Power Supply or other external source of power when used with 7854, 7603, 7633, or 7623.*

*5 *Bandwidths given for 10X switch position.*

NC = Not Compatible.

If there is no bandwidth specified, the probe/plug-in combination is compatible but not recommended.

PROBE FEATURES

Passive Voltage 1-MΩ Compatible
P6101A and P6105A—Miniature, 1X
P6130 and P6106A—Miniature, fast rise time, 10X
P6131—Subminiature, fast rise time, 10X
P6055—Adjustable attenuation, 10X High CMRR
P6062B—Selectable 1X, 10X attenuation
P6009—100X, 1.5 kV
P6015—1000X, 40-kV peak

Passive Voltage 50-Ω Input Compatible
P6056—Fastest 10X passive probe
P6057—Fastest 100X passive probe

Active 50-Ω/1-MΩ Input Compatible
P6201—Low capacitive loading, AC coupling, DC offset
P6202A—10-MΩ input impedance,DC offset
P6230—ECL bias/offset 10X
P6046—Differential, high CMRR

7000-SERIES MAINFRAME/TIME BASE/CAMERA SELECTION GUIDE

	Time Bases							Cameras					
Plug-In	**7B50A**	**7B53A**	**7B80**	**7B85**	**7B92A**	**7B10**	**7B15**	**C-51**	**C-53**	**C-59**	**C-5C**	**C-7**	**C-4 Opt 02**
Features*1	**Single Time Base**	**Dual Time Base with Mixed Sweep**	**Single Time Base**	**Single Time Base with Delaying Δ Delay**	**Dual Time Base with Display Switching**	**Single Time Base**	**Single Time Base with Delaying Δ Delay**	**High Writing Rate**	**General Purpose**	**General Purpose**	**Low Cost**	**Low Cost**	**Low Cost**
7104					✓	✓	✓		✓		✓	✓	✓
7904A			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
7934			✓	✓	✓	✓	✓		✓		✓	✓	✓
7844			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
7854		Opt 05*2	✓	✓*2	✓*2	✓	✓*2	✓	✓		✓	✓	✓
7603	✓	✓								✓	✓	✓	✓
7633 7623A	✓	✓							✓		✓	✓	✓
Prices begin at	$1,320	$2,085	$1,715	$2,140	$3,870	$2,640	$3,000	$2,410	$1,990	$1,375	$495	$595	$375

*1 *Camera/time base recommendation the same for rack mount version of scope.*
*2 *Single-sweep mode operable for real time only.*

7000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

ANALOG SCOPES

Dimensions		**7104**	**R7103**	**7904A**	**R7903**	**7934**	**7844**	**R7844**	**7603**	**R7603**	**7633, 7623A**	**R7633, R7623A**
Width	mm	305	483	305	483	305	305	483	221	483	221	483
	in.	12.0	19.0	12.0	19.0	12.0	12.0	19.0	8.7	19.0	8.7	19.0
Height	mm	345	178	345	135	345	328	178	290	133	305	133
	in.	13.6	7.0	13.6	5.3	13.6	12.9	7.0	11.4	5.3	12.0	5.3
Depth	mm	592	704	577	579	622	605	630	610	627	597	566
	in.	23.3	27.7	22.7	22.8	24.5	23.8	24.8	24.0	24.7	23.5	22.3
Weights ≈												
Net	kg	19.8	20.0	16.9	12.3	17.2	16.3	15.0	13.6	13.6	13.6	14.5
	lb	45.0	44.0	37.2	27.0	37.8	36.0	33.0	30.0	30.0	30.0	32.0
Shipping	kg	25.4	30.9	21.4	23.6	21.6	21.6	28.5	20.8	19.0	19.0	28.2
	lb	56.0	68.0	47.0	52.0	47.6	47.0	63.0	46.0	42.0	42.0	62.0

DIGITAL SCOPES/DIGITIZERS/PLUG-INS

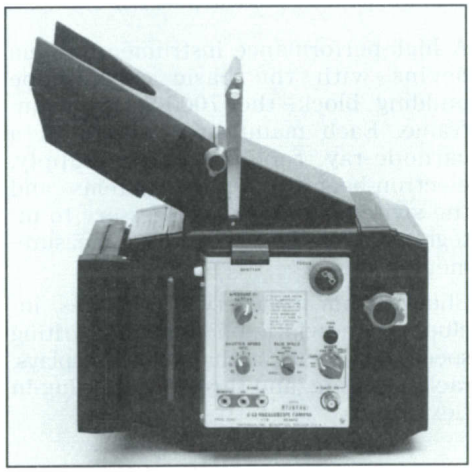
					Plug-Ins	
Dimensions		**7612D**	**7912HB**	**7854***	**Single**	**Double**
Width	mm	483	483	305	71	140
	in.	19.0	19.0	12.0	2.8	5.5
Height	mm	178	178	348	127	127
	in.	7.0	7.0	13.7	5.0	5.0
Depth	mm	703	679	627	368	368
	in.	27.7	26.8	24.7	14.5	14.5
Weights ≈						
Net	kg	25.0	24.7	20.4	0.9	4.1
	lb	55.0	54.6	45.0	2.0	9.0
Shipping	kg	42.1	32.6	28.1	2.3	5.4
	lb	93.0	72.0	62.0	5.0	12.0

* *Calculator dimensions and weights, width 277 mm (10.9 in), height 69 mm (2.7 in), depth 165 mm (6.5 in).*

APPLICATION NOTES FOR 7000 SERIES

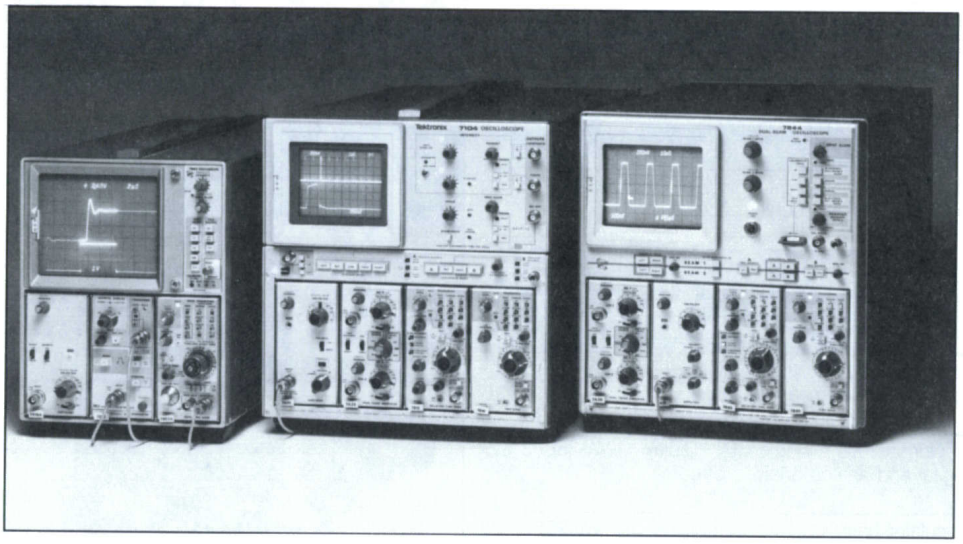
Title	Description	Order
Pulse Echo Measurements with digital accuracy	7603/7A22/7D15/7B53A timing measurements Pulse Echo Measurements between nonadjacent pulses.Ultrasonic transducers	42-W-3681-1
7A42 Logic Triggered Amplifier	Checking logic levels	42-W-5629
7A42 Bus Contention	Microprocessor Bus Contention measurements	42-W-5630
7A42 Advanced Trigger Application	7A42 measures complex signals easily	42-W-5588
X-Y Displays with Interval Timing for Measuring SOA	7D15/7A18/7A22 X-Y power dissipation measurements	42-AX-3957
DAC Measurements: The sampling oscilloscope approach	7S14/7D12/M2/7B92A/7904 measuring DAC (digital analog converter) settling time	42-W-3632-1
Measuring time interval between nonadjacent digital word train pulses or multiecho radar pulses	7D15 demonstrates ability to measure the time between adjacent pulses with digital counter accuracy	42-W-2680-3
The 7D20 Programmable Digitizer: Performing a Wide Range of Measurement Tasks Easier, Faster, and more Accurately	7D20 application examples including ultrasonic testing, monitoring nerve activity, measuring pulse jitter, and SOA analysis of power devices	42-W-5085
Measuring memory core I/O signals with digital accuracy	7000 Series digital plug-ins demonstrate how to make accurate pulse parameter measurements both of amplitude and pulse timing	42-AX-2686-1
Measuring disc drive time and access voltages with Tektronix 7000 Series Digital Plug-ins	7000 Series digital plug-ins use a single CRT display to perform both digital and analog analysis of complex waveforms	42-W-2687-2
Measurement Variety: An Engineering challenge featuring the 7854	7854/Waveform Calculator basic operation, application software for percent overshoot, data monitoring and histogram	42-W-4281-1
GPIB communication with the 7854	7854/4052/7854/4924 I/O transfers, transmissions formats, and operating software in TEK BASIC compatible with 4050 Series computer	42-W-4416-1
Pulse and digital timing measurements—a better technique	7B80/7B85 general operation overview	42-AX-3379-1
Using storage to find troublesome logic glitches	7633 shows how to capture/evaluate glitches	42-AX-3085
Variable persistence storage applications	7613/5441 various applications for variable persistence storage oscilloscopes	42-AX-3198
Automated TDR Testing	Made easy with the 7854/7S12	42-W-5334-1
Tektronix Storage Oscilloscopes	Describes various applications	42-AX-3199
Increased measurement accuracy using a 7D15 in any 7000 Series scope	Introduction demonstrating variety of counting and timing measurements	42-W-5017-1
7D20 Programmable Digitizer: Digitizing Performance and versatility in a power plu-in	In-depth discussion of the features, functions and capabilities	42-W-5079-1
Sampling for High Speed Measurements	Describes how sampling works, TDR measurements, probes and sampling systems	42-W-5195
Measurement Techniques with Differential Amplifiers	Outlines what they are, functions and benefits	42-W-5325
Applying Photographic Writing Rate to High Speed Signal Measurements	Describes how scope/camera systems photograph fast moving traces	42-W-5335-1
Power Supply/Device Testing	Describes advanced 7854 waveform processing functions of typical series of five power supply and device test operations	42-W-5700
Basic SW Program for Communcation Between 7854 and IBM PC	Describes installation and configuration of National Instrument's IEEE-488 card, and programs to make transfers and specific programs in IBM BASIC	42-W-5802-1
7854 Measurement Primer	Teaches most basic functions, including acquiring waveform, stored waveform measurements, storing/displaying multiple waveforms	42-W-5968
Sampling Primer	Basic sampling principles in signal acquisition for scope measurements	42-W-5969

K213 Lab Instrument Cart
The K213 Lab Instrument Cart accepts all 7000-Series oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test-and-Measurement instruments, 5000-Series oscilloscopes, or 400-Series oscilloscopes. A drawer for the 7854 keyboard and a plug-in storage cabinet are available as Options 10 and 12 respectively, or Option 22 for both. For full details, see Scope-Mobile Carts in the Accessories section.



TEK C-53 Camera
The full line of cameras designed for 7000-Series oscilloscopes is summarized on the preceding page. For full details, see the Camera part of the Accessories section.

7000-SERIES NONSTORAGE MAINFRAMES



CONTENTS

7104/R7103 1-GHz General Purpose 249
7904A/R7903 500-MHz General Purpose 252
7603/R7603 100-MHz General Purpose 254
7844/R7844 400-MHz Dual Beam 256
CRT-Storage Mainframes 258
Plug-Ins 264
High-Performance Digitizing Mainframes 353

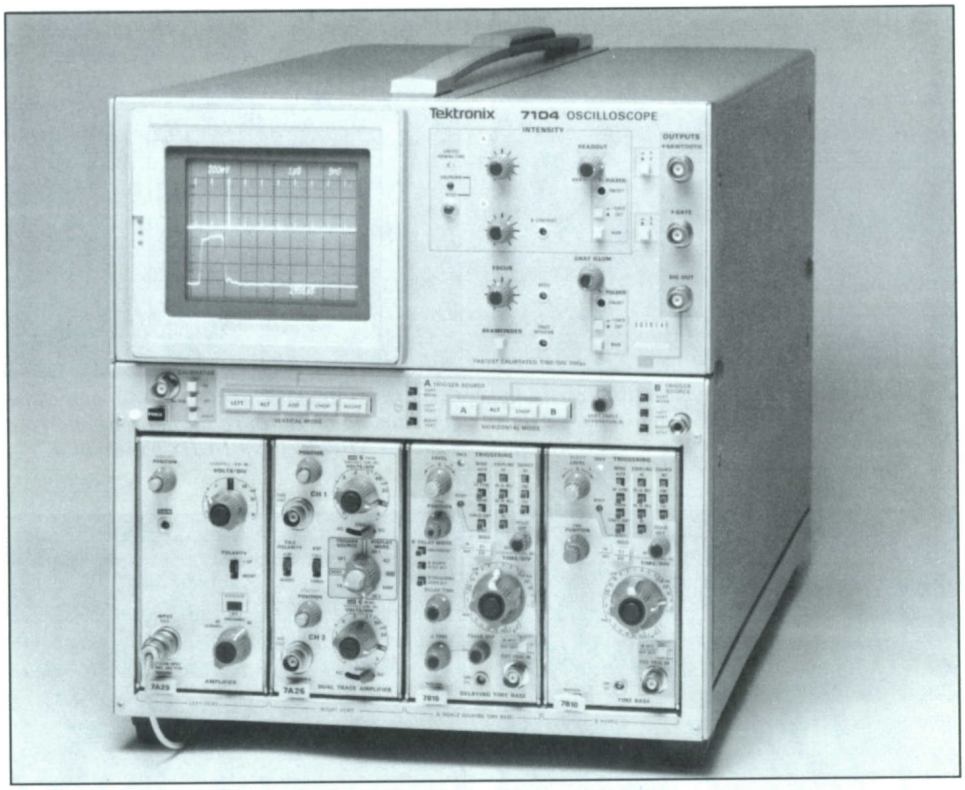
7000-SERIES NONSTORAGE SELECTION GUIDE

Features	7104/R7103	7904A/R7903	7844/R7844	7603/R7603
Bandwidth*1	1 GHz	500 MHz	400 MHz	100 MHz
Minimum Deflection Factor	10 mV/div at BW	10 mV/div at BW 10 μV/div 1 mA/div	20 mV/div at BW 10 μV/div 1 mA/div	5 mV/div at BW 10 μV/div 1 mA/div
Maximum Sweep Rate	200 ps/div	500 ps/div	1 ns/div	5 ns/div
Four Traces	✓	✓	✓ Dual Beam	✓
Delayed Sweep	✓	✓	✓	✓
Prices begin at*2	$26,695/$27,275	$10,980/$9,840	$16,595/$16,670	$4,235/$4,805

*1 *Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
*2 *Price does not include plug-ins.*

A high-performance instrument system begins with the basic oscilloscope building block—the 7000-Series mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron-beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

Choose from a variety of features, including bandwidth, photographic writing speed, dual beam, alphanumeric displays, rackmounting, and three or four plug-in flexibility.



7104/R7103

- **1-GHz at 10 mV/Div**
- **350-ps Rise Time**
- **200-ps/Div Fastest Calibrated Sweep Rate**
- **Horizontal Bandwidth 350 MHz**
- **Ultra-High Photographic Writing Speed—at Least 20 cm/ns**
- **CRT Readout**
- **7-Inch Rackmount (R7103 Only)**
- **Phase Compensation Option—Phase Matching to 250 MHz (7104 Only)**

TYPICAL APPLICATIONS

High-Speed Semiconductor Design
Laser and High-Energy Research
Digital Communications

See the 7000-Series Reference section for available Application Notes.

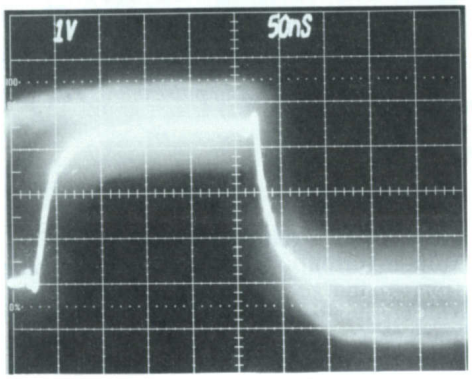
The capabilities of the 7104 and of the seven-inch rackmount R7103 are of substantial value in numerous high-technology environments. The 7104/R7103 have both the highest writing speed and highest bandwidth available in a general-purpose oscilloscope today.

The 7104/R7103's outstanding writing speed means unsurpassed single-shot capability, with trace brightness about one-thousand times that of conventional oscilloscopes. Any single-shot signal within the 1-GHz bandwidth can be seen directly on the CRT in average room light. Also, single-shot photography is now simple and straightforward, using standard oscillographic cameras and film without high-speed enhancement techniques.

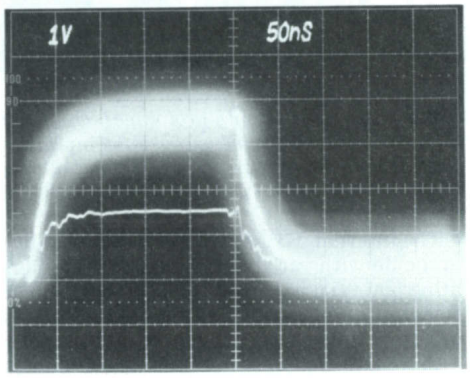
It is by no means unusual to see 250-MHz data rates and 900-MHz analog frequencies outside the lab and on the production line. In digital design, too, anomalies such as ringing and overshoot can only be dealt with by evaluating the signal's analog characteristics.

You can capture the fastest transients without expensive high-speed film or other time-consuming and complex techniques like fogging or reducing the scan. In fact, you can see those signals on the CRT, and eliminate costly time-consuming photographs.

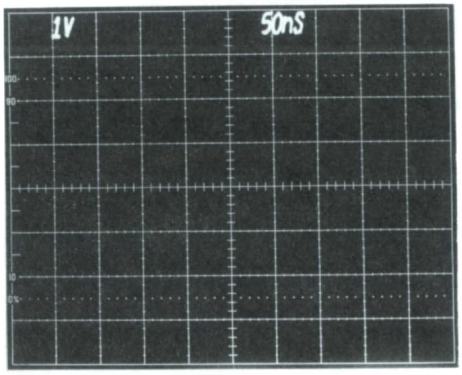
Horizontal bandwidth of 350 MHz, with the X-Y phase-compensation Option 02 (7104), gives accurate X-Y displays to 250 MHz. Designers can now directly obtain V-I curves for high-speed switching-power-supply evaluation or monitor performance of digital-communication systems using phase-constellation displays.



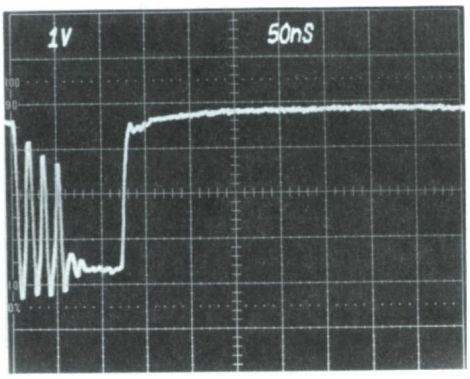
Before—A pulse train on a TEK 7904A doesn't reveal the low-level glitch occurring every ten-thousandth pulse. (The TEK 7904A was previously the world's fastest writing-rate scope.)



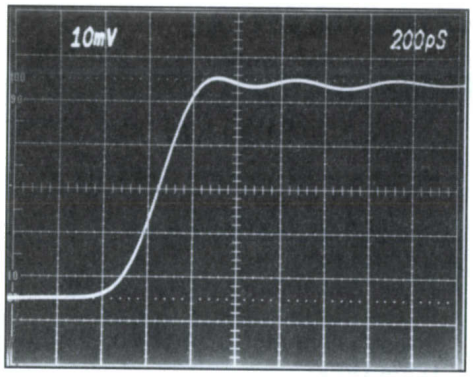
After—The same pulse train viewed directly on the 7104/R7103, with one-thousand times the brightness of conventional scopes. The researcher can now analyze the pulse with the naked eye and take pictures with ease.



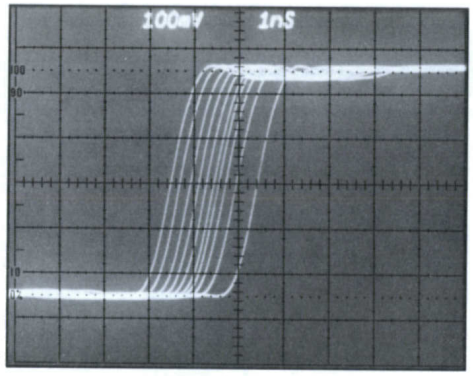
Before—Low-repetition-rate pulse is invisible on a conventional oscilloscope.



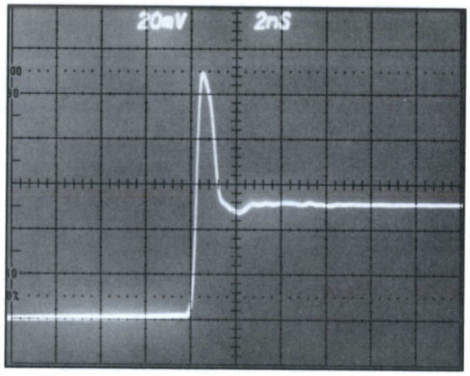
After—The same pulse as seen on the 7104/R7103 readily indicates that the problem is input-signal bounce.



With its sweep speed of 200 ps/div, the 7104/R7103 clearly shows a single-shot, 350-ps step, five divisions in amplitude.



A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0-ns jitter when viewed with the distinct image-viewing capability of the 7104/R7103.



Circuit faults such as high-frequency pulse overshoot and ringing can easily be observed with the 7104/R7103's 1-GHz bandwidth.

CHARACTERISTICS

The following characteristics are common to the 7104 and the R7103, except those noted under the R7103.

VERTICAL SYSTEM

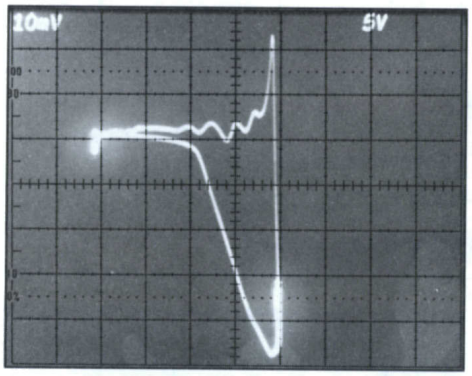
Channels—Two left-hand plug-in compartments. Compatible with all 7000-Series plug-ins (except 7D01, 7D02, and 7D20).
Bandwidth—Determined by mainframe and plug-in unit. See the 7000-Series Reference section.
Rise Time—Determined by mainframe and plug-in unit. See the 7000-Series Reference section.
Deflection Factor—Determined by plug-in unit. See the 7000-Series Reference section.
Display Modes—Left, Alt, Add, Chop, Right. Chopped-mode repetition rate is ≈1 MHz.
Trace Separation—(7104 only) In dual-sweep modes, positions B trace at least four divisions above and below A trace.
Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

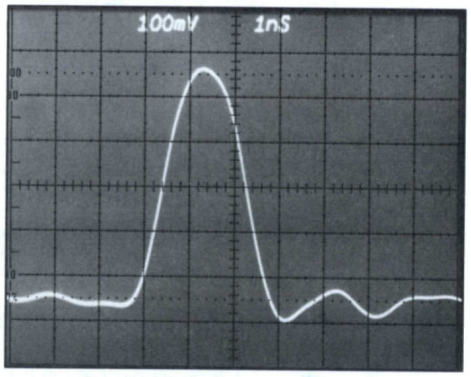
Channels—Two right-hand plug-in compartments. Compatible with the 7B10 Series, 7B80 Series, 7B50A, 7B92A, 7000-Series vertical amplifiers and specialized plug-ins (7B92, 7D01, 7D02, and 7D20 not recommended).
Bandwidth—DC to 350 MHz.
Display Modes—(7104 only) A, Alt, Chop, B. Chopped-mode repetition rate is ≈200 kHz.
Fastest Calibrated Sweep Rate—200 ps/div with the 7B10 or 7B15.
X-Y Mode—With Option 02, X-Y Phase Compensation (7104 only, using 7A19s or 7A29s with at least one having Variable Delay Option, B horizontal compartment only): Phase shift is 2° from dc to 50 MHz (after adjusting variable delay for balance at 35 MHz). Phase balance can be obtained at any frequency up to 250 MHz. Without Option 02, X-Y Phase Compensation: Phase shift is 2° from dc to 50 kHz.

CRT AND DISPLAY FEATURES

For CRT phosphor data see Oscilloscope Reference section.



The transient load line of a fast switching transistor in a power-supply prototype (switching time = 10 ns) is easily measured for compliance with safe operating area (Horizontal = Voltage; Vertical = Current).



View of a single clocking pulse 0.8-ns rise and 2-ns pulse width.

CRT—Internal 8×10-division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV. GH (P31) phosphor.
Readout and Graticule Modes—Continuous or pulsed. Pulse source front-panel selectable: +Gate, External, Manual. Pulsed graticule is on for ≈0.5 s.

Typical Photographic Writing Speed*1

CRT	Camera	Lens	Writing Speed (cm/ns)
Standard 8×10 cm	C-53	f/1.9 1:0.85	20

*1 *Using the standard GH (P31) phosphor and Polaroid Type 107, 3,000 ASA film without film fogging.*

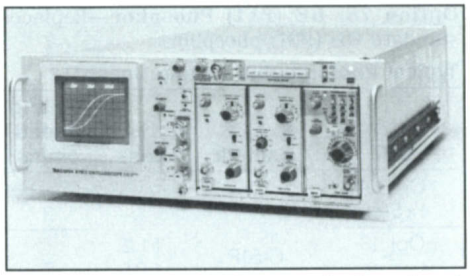
Autofocus—Reduces the need for additional manual focusing with changes in intensity after focus control has been set.
Beam Finder—Aids in locating offscreen signal.
External Z-Axis Input—2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

CALIBRATOR

Voltage Output—Square wave positive going from ground.
Voltage Ranges—40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%. Repetition rate is 1 kHz within 0.25%.
Current Output—40 mA rectangular waveshape with optional current loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS

+Sawtooth—Starts 1 V or less from ground into 1 MΩ. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.
+Gate—Positive-going rectangular waveform. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is ≈950 Ω.
Vertical Signal Out—Output voltage is 25 mV/div into 50 Ω, 0.5 V into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See the 7000-Series Vertical-System Specifications in the 7000-Series Reference section.
Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series camera.



The R7103 requires only seven inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slideout chassis.

Probe Power—Two rear-panel connectors for active probes (i.e., P6201, P6202A, P6230).
External Single-Sweep Reset—Ground closure, rear-panel BNC, input to reset sweep.
Single-Sweep Ready Indicator—Rear-panel BNC provides 5 V out to indicate single-sweep ready condition.
Graticule/Readout, Single Shot—Ground closure, rear-panel BNC input initiates one frame of CRT readout. Graticule is illuminated for ≈0.5 s.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 132 V ac and 180 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—215 W, 3.3 A at 90-V line, 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.
Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: 15 minutes along each of the three major axes. 4 mm (0.015 in.) p-p displacement 10 to 50 to 10 Hz in one-minute cycles. Held for three minutes at 50 Hz.
Humidity—Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.
Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.
EMC Capability—(R7103, 7104 Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL STD-462. Contact your Tektronix representative for more information.
Safety—UL listed (UL 1244) and CSA certified (CSA 556B).

The 7D01, 7D02 Logic Analyzers and 7D20 Digitizer are not recommended for use in the 7104/R7103 mainframe. Such use will void the 7104/R7103 warranty.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	305	12.0	483	19.0
Height	345	13.6	178	7.0
Depth	592	23.3	704	27.7
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	20.4	45.0	20.0	44.0
Shipping	25.4	56.0	30.9	68.0

CHARACTERISTICS (R7103)

The following characteristics for the R7103 are in addition to or in lieu of those listed previously.

HORIZONTAL SYSTEM

Single Channel—Right-hand plug-in compartment compatible with time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except 7B50A), the 7B70 Series, and the 7B92 (non-A) are not recommended. 7000-Series vertical amplifiers and specialized plug-ins (except 7D01, 7D02, and 7D20) may also be used.
Bandwidth—DC to 350 MHz.
X-Y Mode—Phase shift is 2° from dc to 50 kHz.

OUTPUTS/INPUTS

Vertical Signal Out—Output voltage is 25 mV/div within 25% into 50 Ω, 0.5 V into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See the 7000-Series Vertical-System Specifications in the 7000-Series Reference section.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7104 Oscilloscope **$26,695**
Includes: Power cord (161-0066-00); instruction manual (070-2314-00).
R7103 Rackmount Oscilloscope **$27,275**
Includes: Power cord (161-0066-00); mask frame (426-0514-00); CRT filter (378-0625-00); drawer slide (351-0375-01); right spacer (361-0806-00); left spacer (361-0807-00); hardware kit (016-0099-00); instruction manual (070-5039-00).

OPTIONS (7104)

Option 02—X-Y Horizontal Compensation. **+$315**
Option 03—EMC Capability. **+$395**

CONVERSION KIT (7104)

EMC Modification—Order 040-0965-00 **$605**

INTERNATIONAL POWER PLUG OPTIONS

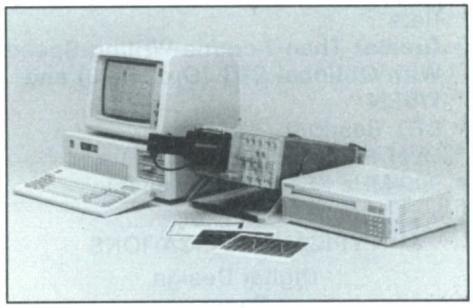
Option A1—Universal Euro 220 V, 50 Hz
Option A2—UK 240 V, 50 Hz
Option A3—Australian 240 V, 50 Hz
Option A4—North American 240 V, 60 Hz
Option A5—Switzerland 220 V, 50 Hz

RECOMMENDED PLUG-INS

7A29—Vertical amplifier, 50-Ω input, dc to 1 GHz; 10-mV/div to 1-V/div vertical sensitivity. **$3,540**
7A42—Four-channel, 350-MHz bandwidth vertical amplifier with Boolean logic triggering capabilities. **$5,415**
7B10—Delayed time base with 200-ps/div to 0.2-s/div calibrated sweep speed; triggering up to 1 GHz. **$2,640**
7B15—Delaying time base with 200-ps/div to 0.2-s/div calibrated sweep speed; triggering up to 1 GHz; capable of Δ time measurements in conjunction with 7B10. **$3,000**
7B92A—Dual time base with 500-ps/div to 0.2-s/div calibrated sweep speed; triggering up to 500 MHz; capable of delay-time measurements. **$3,870**

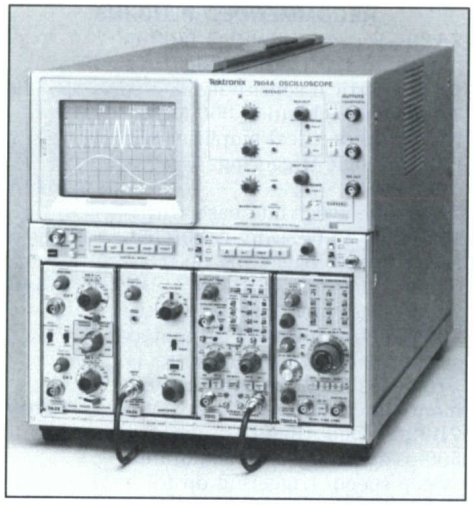
OPTIONAL ACCESSORIES

Recommended Cameras—See Camera Selection Guide in the Accessories section.



The DCS01 Digitizing Camera System combines CCD technology with an IBM PC, XT, AT, or compatible to acquire and digitize repetitive and transient waveforms displayed on oscilloscopes, spectrum analyzers, and other displays. Used with scopes having the microchannel-plate CRT, such as the 7104 and 2467, the DCS01 can acquire repetitive and transient signals at the full bandwidth of the scope. With other scopes, the DCS01 will acquire repetitive events at the full scope bandwidth and transient events according to the photographic writing rate of the oscilloscope.

Recommended Probes—See the 7000-Series Oscilloscope Systems/Probe Selection Guide in the 7000-Series Reference section.
Recommended Carts—
K213 Option 12 (7104), see the Instrument/Cart Compatibility chart in the Accessories section.
K217 (R7103), see the Instrument/Cart Compatibility chart in the Accessories section.



7904A/R7903

- **500 MHz at 10 mV/Div**
- **700-ps Rise Time (7904A)**
- **500-ps/Div Fastest Calibrated Sweep Rate**
- **Greater Than 7-cm/ns Writing Speed With Optional CRT (Option 13) and WSEN**
- **CRT Readout**
- **Over 30 Compatible Plug-Ins**
- **900-MHz FET Probe Available**

TYPICAL APPLICATIONS

Digital Design
Radar
Laser Research

See the 7000-Series Reference section for available Application Notes.

The 7904A and 5.25-inch rackmount R7903 are high-bandwidth, general-purpose oscilloscopes. The 7A29 Amplifier/7904A mainframe attains 500 MHz at 10 mV/div. A 7A29 variable-delay option allows for the matching of signal-transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900-MHz bandwidth by itself, and in combination with the 7A29/7904A, it provides a system bandwidth of 450 MHz at 10 mV/div.

The CRT, the major contributor to the performance of the 7904A and R7903, has good visual brightness and an 8×10-cm display area.

For high photographic-writing-speed applications, Option 13 provides BE (P11) phosphor and a reduced-scan CRT yielding greater than 7-cm/ns photographic-writing rate. Addition of WSEN (writing-speed enhancer described in the Oscilloscope Reference section) increases writing speed to >7 cm/ns. For comparison of 7000-Series photographic writing speeds, see the Photographic Writing-Rate Comparison graph in the Oscilloscope Reference section.

CHARACTERISTICS

The following characteristics are common to the 7904A and R7903, except those noted under the R7903.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments. Compatible with all 7000-Series plug-ins.

Bandwidth, Rise Time, and Deflection Factor—Determined by plug-in unit. See 7000-Series Vertical-System specifications in the 7000-Series Reference Section.

Display Modes—Left, Alt, Add, Chop, Right. Chopped-mode repetition rate is ≈1 MHz.

Trace-Separation Range—(7904A only) In dual-sweep modes, positions B trace at least four divisions above and below A trace.

Delay Line—Permits viewing leading edge of displayed waveform when using 7B80- and 7B90-Series time bases. 7B50-Series not recommended.

HORIZONTAL SYSTEM

Channels—7904A: Two right-hand plug-in compartments. R7903: One right-hand plug-in compartment. 7904A and R7903: Compatible with 7B80- and 7B90-Series time bases, 7000-Series vertical amplifiers and specialized plug-ins.

Bandwidth—DC to at least 1 MHz.

Display Modes—A, Alt, Chop, B. Chopped-mode repetition rate is ≈200 kHz.

Fastest Calibrated Sweep Rate—500 ps/div with the 7B92A.

X-Y Mode—With Delay Compensation: Phase shift is within 2° from dc to 1 MHz. Without Delay Compensation: Phase shift is within 2° from dc to 35 kHz.

CRT AND DISPLAY FEATURES

For CRT phosphor data see Comparative CRT-Phosphor Data chart in the Oscilloscope Reference section.

CRT—Internal 8×10-division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

Option 04, CRT With Reduced Area—Internal 4×5-cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

Option 13, Maximum Brightness CRT With Reduced Area—Internal 4×5-cm graticule with variable illumination. Accelerating potential is 24 kV with BE (P11) phosphor.

Option 78, BE (P11) Phosphor—Replaces standard GH (P31) phosphor.

Typical Photographic Writing Speed*[1]

CRT	Camera	Lens	Writing Speed cm/ns
Opt 04 4×5 cm	C-51P	f/1.2 1:0.5	2
Opt 13 4×5 cm			7
Opt 78 8×10 cm			2.5

*[1] *Using Polaroid Type 612 20,000 ASA Film without film fogging.*

In typical applications, GH (P31) phosphor has approximately one-half the writing speed of BE (P11) phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory).

Autofocus—Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder—Aids in locating offscreen signal.

External Z-Axis Input—2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

CALIBRATOR

Output Waveshape—Rectangular positive going from ground.

Voltage Ranges—40 mV, 0.4 V, 4 V into an open circuit. 4 mV, 40 mV, 0.4 V into 50 Ω. Amplitude accuracy is within 1%. Repetition rate is 1 kHz within 0.25%.

Current Output—40 mA with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS

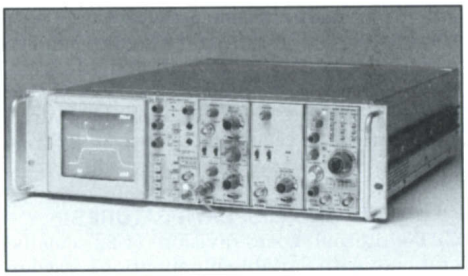
+Sawtooth—Sawtooth starts 1 V or less from ground into 1 MΩ. Front-panel selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

+Gate—Positive-going rectangular waveform derived from A, B, or Delayed Gate, front-panel selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω.

Vertical Signal Out—Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See 7000-Series Vertical-System Specifications in the 7000-Series Reference section.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

Probe Power—Two rear-panel connectors for two active probes.



The R7903 requires only 5.25 inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slideout chassis tracks.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 132 V ac and 180 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—210 W, 3.5 A at 90-V line, 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.
Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 to 55 to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.
Humidity—Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.
Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.
EMC Capability—(Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.
Safety—UL listed (UL 1244) and CSA certified (CSA 556B) 7904A only.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	305	12.0	483	19.0
Height	345	13.6	135	5.3
Depth	577	22.7	579	22.8
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	16.9	37.2	12.3	27.0
Shipping	21.4	47.0	23.6	52.0

CHARACTERISTICS (R7903)

The following characteristics for the R7903 are in addition to or in lieu of those listed previously.

HORIZONTAL SYSTEM

Channel—Single right-hand plug-in compartment. Compatible with 7B80 Series, 7B90 Series, 7000-Series vertical amplifiers and specialized plug-ins.

Fastest Calibrated Sweep Rate—500 ps/div with the 7B92A.

CRT AND DISPLAY FEATURES

Option 10, Pulsed Graticule—Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front-panel pushbutton. If the mainframe is equipped with CRT readout, Option 10 provides additional controls and inputs for CRT readout pulsed operation.

CALIBRATOR (NOT AVAILABLE WITH OPTION 10)

Voltage Ranges—4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω.
Current Output—40 mA rectangular waveshape with optional current loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS (STANDARD)

+Sawtooth—Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.
+Gate—Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 7 ns or less into 50 Ω. Output R is ≈950 Ω.
Vertical Signal Out—Selected by Trigger Source switches. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See 7000-Series Vertical-System Specifications in the 7000-Series Reference section.
External Single-Sweep Reset—Ground closure, rear-panel input to reset sweep.
Single-Sweep Ready Output—Rear-panel BNC provides 5 V out to indicate single-sweep-ready condition.
Probe Power—Two front-panel connectors for two active probes. Not available for Option 10.
CRT Readout—Inhibit: Ground closure, rear-panel BNC input locks out CRT readout. Not available with Option 10. Single Shot: Ground closure, rear-panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed-graticule input.

OUTPUTS/INPUTS (OPTIONS)

Option 10, Pulsed Graticule—No CRT readout single-shot input, CRT-readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear-panel BNC input is added. Initiates one frame of CRT readout and pulsed graticule.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 132 V ac and 180 to 264 V ac.
Maximum Power Consumption—160 W, 2 A at 115-V line, 60 Hz.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Ordering information is common to the 7904A and R7903 unless otherwise noted.

7904A Oscilloscope **$10,980**
Includes: Power cord (161-0066-00); instruction manual (070-4593-00).

R7903 Oscilloscope **$9,840**
Includes: Power cord (161-0066-00); test adaptor (012-0092-00); two 18-in. test leads (012-0087-00); slide guide (351-0314-01); hardware kit (016-0099-00); instruction manual (070-1464-00).

OPTIONS

Option 02—(7904A only) X-Y Horizontal Compensation. Adds X-Y delay compensation network to equalize the signal delay between the vertical and the B horizontal compartments. **+$260**
Option 03—EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**
Option 04—(R7903 only) Reduced Scan 4×5-cm CRT Display. GH (P31) Phosphor is standard. **+$500**
Option 10—(R7903 only) Pulsed Graticule. **+$260**
Option 13—Maximum Brightness 4×5-cm CRT Display with BE (P11) Phosphor. **+$600**
Option 78—BE (P11) Phosphor. **+$100**

CONVERSION KITS

X-Y Horizontal Compensation—
(7904A only) Order 040-0606-00 **$470**
EMC Capability—
(7904A) Order 040-0570-00 **$490**
(R7903) Order 040-0647-00 **$375**
CRT Readout—
(R7903 only) Order 040-0605-06 **$520**

INTERNATIONAL POWER PLUG OPTIONS

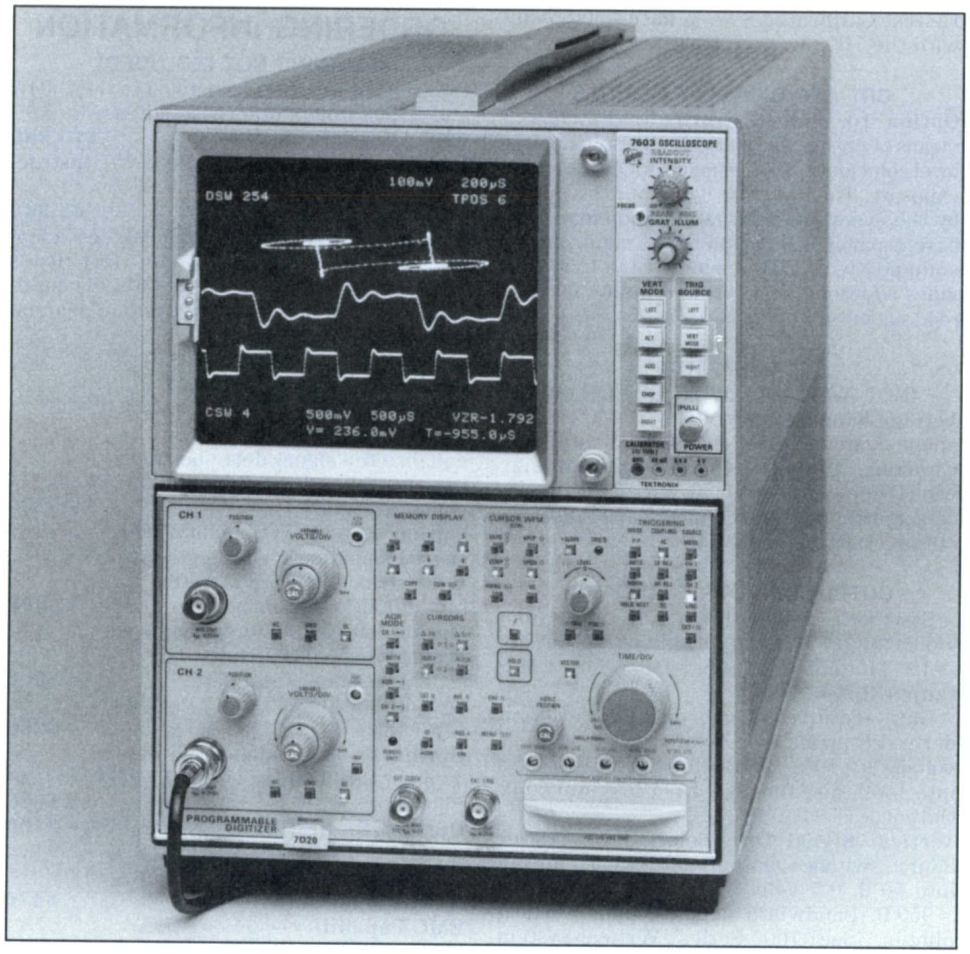
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins—See 7000-Series Vertical-System Specifications in the 7000-Series Reference section.
Recommended Probes—See 7000-Series Oscilloscope Systems/Probe-Selection Guide in the 7000-Series Reference section.
Recommended Cameras—See 7000-Series Mainframe/Time Base/Camera Selection Guide in the 7000-Series Reference section.
Recommended Carts—K213 Option 12 (7904A), See Instrument/Cart Compatibility chart in the Accessories section.
K217 (R7903), See Instrument/Cart Compatibility chart in the Accessories section.

TRAINING

Tektronix offers service training classes on the 7904A General-Purpose Oscilloscope. For further training information, contact your local Sales/Service Office and request a copy of the Customer Service Training Catalog.



7603/R7603

- **DC to 100-MHz Bandwidth**
- **3.5-ns Rise Time**
- **5-ns/Div Fastest Calibrated Sweep Rate**
- **Greater Than 260-cm/µs Writing Speed With Optional CRT (Option 13)**
- **6.5-Inch CRT**
- **CRT Readout**
- **5.25-Inch Rackmount**

TYPICAL APPLICATIONS

Digital Design and Testing
Communications
Spectrum Analysis

See 7000-Series Reference section for available Application Notes.

The Tektronix 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100-MHz plug-in oscilloscope market today.

The CRT is large—8×10 divisions (1.22 cm/div)—and features an internal graticule with variable illumination and 15-kV accelerating potential. An optional high-brightness CRT with a smaller 8×10-cm display and 18-kV potential gives you greater visual brightness and higher photographic-writing speed. See Oscilloscope Reference section for writing-speed specifications.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments. Compatible with all 7000-Series plug-ins.
Bandwidth, Rise Time, and Deflection Factor—Determined by mainframe/plug-in. See 7000-Series Vertical-System Specifications.
Display Modes—Left, Alt, Add, Chop, Right. Chopped-mode repetition rate is ≈1 MHz.
Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels—One right-hand plug-in compartment. Compatible with all 7000-Series plug-ins.
Bandwidth—DC to 2 MHz.
Fastest Calibrated Sweep Rate—5 ns/div.
X-Y Mode—The phase shift is within 2° from dc to 35 kHz.

CRT AND DISPLAY FEATURES

CRT—Internal 8×10-division (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV. GH (P31) phosphor is standard.
Option 01, Without CRT Readout—(CRT readout may be added later with conversion kit 040-0654-04).
Option 04, High-Brightness CRT With Reduced Area—Internal 8×10-cm graticule with variable illumination. Accelerating potential is 18 kV. GH (P31) phosphor.
Option 06, Spectrum-Analyzer Graticule—Provides internal spectrum-analyzer graticule.
Option 13, Maximum-Brightness CRT With Reduced Area—Internal 8×10-cm graticule with BE (P11) phosphor. Accelerating potential 18 kV.
Optional Phosphors (Specify)—GM (P7), BE (P11), or GM (P7)/SA (phosphor/spectrum-analyzer graticule combination).

Typical Photographic Writing Speed*1

CRT	Camera	Lens	Writing Speed cm/µs
Standard 8×10 div	C-53	f/1.9 1:0.85	122
Opt 13 8×10 cm			260
Opt 78 8×10 cm			180

*1 *Using Polaroid Type 107 3,000 ASA film without film fogging.*

Autofocus—Reduces the need for additional manual focusing with changes in intensity after focus control has been set.
Beam Finder—Aids in locating an offscreen signal.
External Z-Axis Input—2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

CALIBRATOR

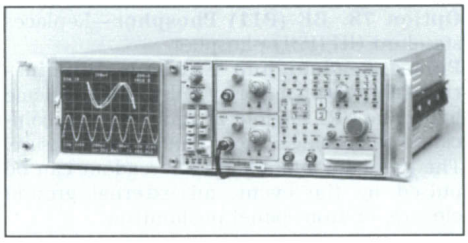
Voltage Output—Rectangular waveshape, positive going from ground (dc voltage available when selected by internal jumper).
Voltage Ranges—40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15 to +35°C); within 2% (0 to +50°C). Repetition rate is ≈1 kHz.
Current Output—40-mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4-V and ground pin jacks. Output R is 950 Ω.

OUTPUTS/INPUTS

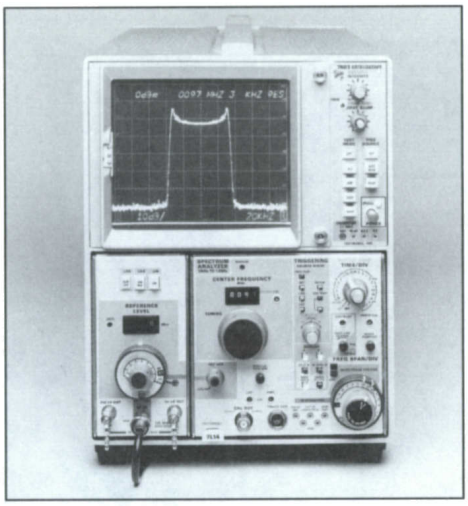
+Sawtooth Out (Rear Panel)—Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is 950 Ω.
+Gate Out (Rear Panel)—Positive gate of the same duration and coincident with sweep. Selectable from Main, Delay, or Auxiliary Gate. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Rise time is 20 ns or less into 50 Ω. Output R is 950 Ω.
Vertical Signal Out (Rear Panel)—Selected by Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is 950 Ω. Bandwidth determined by vertical plug-in. See 7000-Series Reference section.
Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.
External Single-Sweep Reset—Ground closure, rear-panel BNC provides input to reset sweep.
Single-Sweep Ready Output—Rear-panel BNC provides 5 V out to indicate single-sweep ready condition.

POWER REQUIREMENTS

Line-Voltage Ranges—100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.
Line Frequency—50 to 60 Hz.
Option 05, Line-Frequency Change (50 to 400 Hz)—Converts the R7603 and 7603 from 50 to 400 Hz operation.
Maximum Power Consumption—180 W, 2.0 A at 115-V line, 60 Hz. Cooling is provided by a fan.



The R7603 requires only 5.25 inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slideout chassis tracks.



The 7L14 converts the 7603 Oscilloscope to a 1.8-GHz Spectrum Analyzer.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.
Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement, 0 to 55 to 9 Hz in one-minute cycles. Held for three minutes at 55 Hz.
Humidity—Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.
Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.
EMC Capability—(Option 03) Meets MIL-STD-1-A-6181B. Contact your Tektronix representative for more information.
Safety—UL listed (UL1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	221	8.7	483	19.0
Height	290	11.4	127	5.2
Depth	610	24.0	627	24.7
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	13.6	30.0	13.6	30.0
Shipping	20.8	46.0	19.1	42.0

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Ordering information is common to the 7603 and R7603 unless otherwise noted.
7603 Oscilloscope **$4,235**
Includes: Clear CRT filter (337-1700-04); blue CRT filter (337-1700-01); 20-in. two-pin-to-BNC cable (175-1178-00); instruction manual (070-1310-00).
R7603 Rackmount Oscilloscope **$4,805**
Includes: In addition to the above, a rack-mounting hardware kit (016-0099-00).

OPTIONS

Option 01—Without CRT Readout. **NC**
Option 03—EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**
Option 04—High-Brightness 8×10-cm CRT Display. GH (P31) Phosphor. **+$500**
Option 05—Line-Frequency Change (50 to 400 Hz). **+$315**
Option 06—With Internal Spectrum Analyzer Graticule. **+$50**
Option 08 (7603)—Protective Panel Cover. **+$115**
Option 13—Maximum Brightness 8×10-cm CRT Display with BE (P11) Phosphor. **+$600**
Option 20—(R7603) IEEE Standard 488 Interface for the 7D20 only. (Deletes rear panel + sawtooth out, + gate out, and vert sig out.) **+$105**
Option 76—GM (P7) Phosphor. **+$100**
Option 77—GM (P7) Phosphor with Internal Spectrum Analyzer Graticule. **+$100**
Option 78—BE (P11) Phosphor. **+$100**

CONVERSION KITS

CRT Readout—
(7603) Order 040-0654-05 **$900**
(R7603) Order 040-0674-05 **$650**
EMC Capability—
(7603) Order 040-1000-00 **$395**
(R7603) Order 040-0955-00 **$315**
Power Supply—To Light Plug-in Pushbuttons. Order 040-0686-01 **$90**
X-Y Horizontal Comp—
Order 040-0718-00 **$425**

INTERNATIONAL POWER PLUG OPTIONS

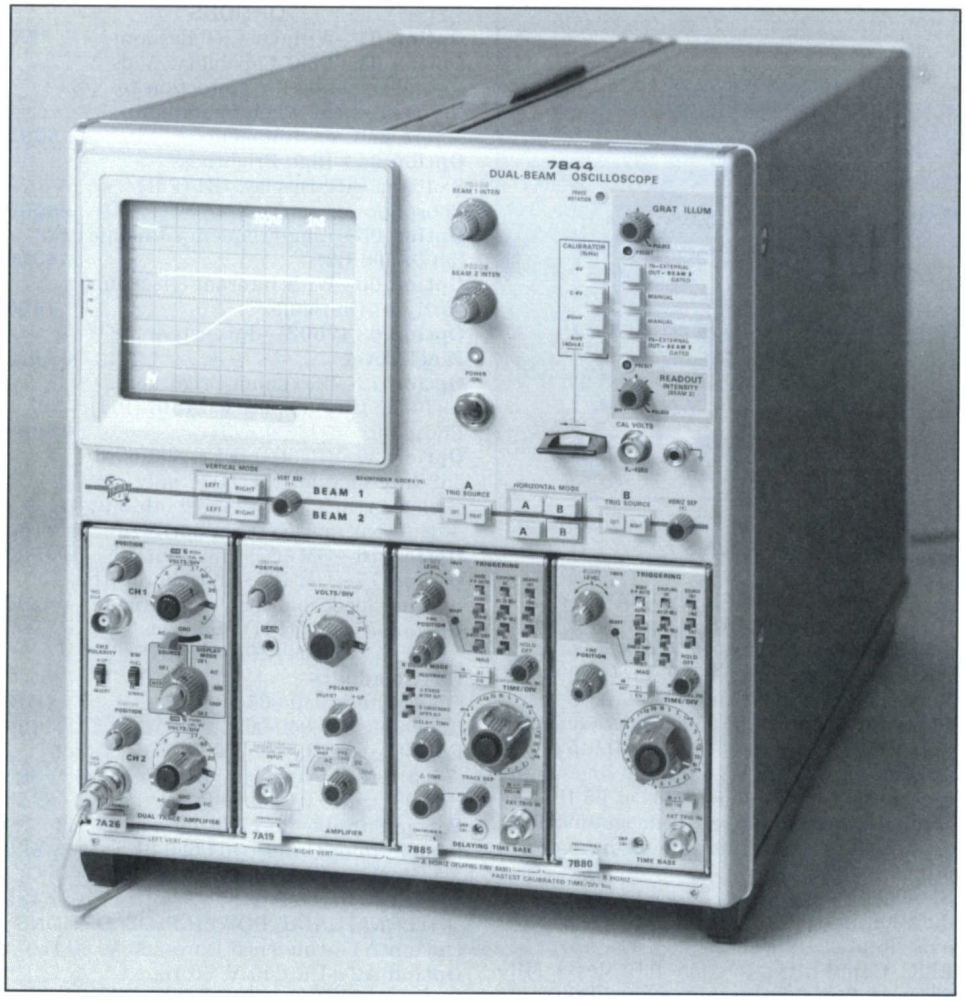
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

FIELD-INSTALLED KITS

Field-Installable Option 20—
(R7603 only) Intended for use with a previously purchased R7603. This kit provides parts to connect the 7D20's IEEE Standard 488 Interface to the R7603 mainframe. Order 040-1093-01 **$500**
International Power Plug Options—Five field installed kits are available. Contact your local Tektronix Sales Office for information.
A1—Universal Euro. Order 040-1094-01
A2—UK. Order 040-1095-01
A3—Australian. Order 040-1096-01
A4—North American. Order 040-1097-01
A5—Switzerland. Order 040-1098-01

OPTIONAL ACCESSORIES

Recommended Plug-Ins, Probes, and Cameras—See 7000-Series Reference section.
Recommended Carts—
K213 Option 12 (7603), K217 (R7603), see Instrument/Cart Compatibility chart in Accessories section.



7844/R7844

- **400-MHz Bandwidth**
- **900-ps Rise Time**
- **1 ns/Div Fastest Calibrated Sweep Rate**
- **Greater Than 1.5-cm/ns Writing Speed**
- **8×10-cm Display**
- **CRT Readout**
- **True Dual Beam (Dual-Gun)**
- **Full Vertical Crossover Switching**

TYPICAL APPLICATIONS

Radar/Lidar
Destructive Testing
SCR Switching

See 7000-Series Reference section for available Application Notes.

The 7844 and seven-inch rackmount R7844 are wide-bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed CRT readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical-signal crossover switching permits you to view a single event from a single probe at two sweep speeds. See Oscilloscope Reference section for photographic writing-speed specifications.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments. Compatible with all 7000-Series plug-ins.

Bandwidth, Rise Time, and Deflection Factor—Determined by mainframe/plug-in. See 7000-Series Vertical-System Specifications.

Display Logic

	Beam 1	Beam 2
Vertical Compartment	Left	Left
Controlling Beam	Left	Right
	Right	Left
	Right	Right

Crossover—Permits viewing the same signal on two time bases.

Trace Separation—Beam 1 can be positioned ±4 cm with respect to Beam 2.

Delay Line—Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. Not compatible with 7B50 Series.

HORIZONTAL SYSTEM

Channels—Two right-hand plug-in compartments. Compatible with 7B80 Series, 7B90 Series, 7000-Series vertical amplifiers, and specialized plug-ins.

Bandwidth—DC to at least 1 MHz.

Fastest Calibrated Sweep Rate—1 ns/div.

X-Y Mode—Phase shift is within 2° from dc to 50 kHz.

Horizontal Separation—Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

Display Logic

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

CRT AND DISPLAY FEATURES

CRT—Dual beam, full overlap. 8×10-cm graticule with variable illumination. CRT readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV. GH (P31) phosphor.

Option 78, BE (P11) Phosphor—Replaces standard GH (P31) phosphor.

Pulsed Readout and Graticule Illumination—Provides a means of pulsing the graticule lights and CRT readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights and CRT readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

Typical Photographic Writing Speed*[1]

CRT	Camera	Lens	Writing Speed cm/ns
Standard 8×10 cm	C-51	f/1.2	0.75
Opt 78 8×10 cm		1:0.5	1.5

*[1] *Using Polaroid Type 107 3,000 ASA film without film fogging.*

The photographic writing-speed enhancer, Option 22, provides a preset automatic method of film fogging for the 7844. Option 22 is recommended for writing-speed enhancement when a camera with a writing-speed enhancer is not available.

Autofocus—Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder (Beam 1 and Beam 2, Independent Controls)—Aids in locating off-screen signal.

External Z-Axis Input (Beam 1 and Beam 2)—2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac), p-p ac, dc coupled.

CALIBRATOR

Voltage Output—Rectangular waveform positive going from ground, 1 kHz (±0.25%).

Voltage Ranges—4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

Current Output—40-mA (±1%) rectangular waveshape. Front-panel current loop on 7844; optional current-loop adaptor (012-0341-00) required for R7844. Output R is 450 Ω.

OUTPUTS/INPUTS

A and B + Sawtooth—Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

A and B + Gate—Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50-Series cameras.

Probe Power—Two connectors provide correct operating voltages for two active probes.

External Single-Sweep Reset—Ground closure, rear-panel BNC, provides input to reset sweeps.

Single-Sweep Ready Output—+5 V, rear-panel BNC output, for single-sweep ready indication.

POWER REQUIREMENTS

Line Voltage Ranges—Selectable 115 V nominal (90 to 132 V), 230 V nominal (180 to 264 V).

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—235 W, 2.9 A at 60-Hz 115-V line.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to +50 °C. Nonoperating: −55 to +75 °C.

Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in.) p-p displacement 10 to 50 to 10 Hz in one-minute cycles. Held for three minutes at 50 Hz.

Humidity—Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.

EMC Capability—(Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	305	12.0	483	19.0
Height	328	12.9	178	7.0
Depth	605	23.8	630	24.8
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	16.3	36.0	15.0	33.0
Shipping	21.3	47.0	28.6	63.0

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Ordering information is common to the 7844 and R7844 unless otherwise noted.

7844 Oscilloscope **$16,595**

Includes: Power cord (161-0066-00); instruction manual (070-1676-02).

R7844 Rackmount Oscilloscope **$16,670**

Includes: In addition to the above a hardware rackmount kit (016-0099-00); slide guide (351-0314-01).

OPTIONS

Option 03—EMC capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

Option 21—Dedicated Mode. Left vertical is dedicated to Beam 1; right vertical is dedicated to Beam 2. **NC**

Option 22—Writing-Speed Enhancer. **+$400**

Option 78—BE (P11) Phosphor. **+$100**

CONVERSION KIT

EMC Capability—
(7844) Order 040-0834-01 **$535**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.

Option A2—UK 240 V, 50 Hz.

Option A3—Australian 240 V, 50 Hz.

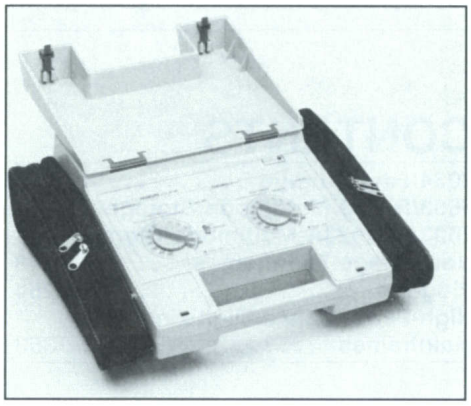
Option A4—North American 240 V, 60 Hz.

Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins, Probes, and Cameras—See 7000-Series Reference section.

Recommended Carts—See Instrument/Cart Compatibility chart in the Accessories section. (7844) K213 Option 12, (R7844) K217.



A6902B Isolator

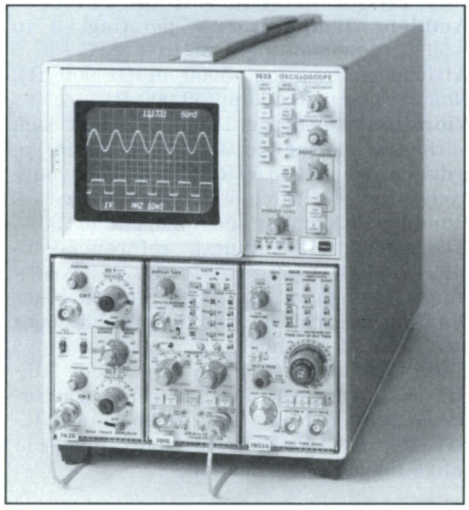
A dual-channel, optical and transformer-coupled voltage isolator, the A6902B allows safely grounded test instruments to make floating measurements at high-sensitivity levels in the presence of large common mode signals.

Designed for use with any dual-channel oscilloscope, the A6902B permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages. See the Accessories section.

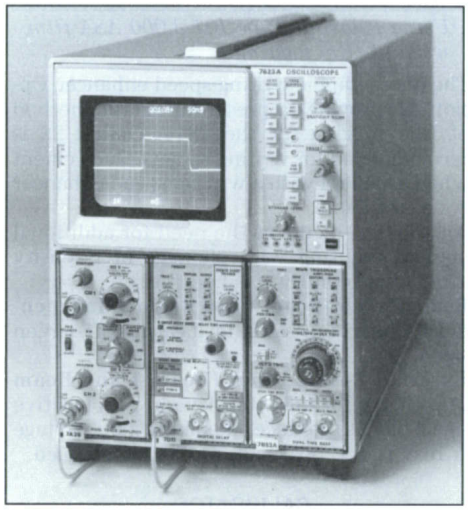
A6902B Isolator **$1,885**

7000-SERIES CRT-STORAGE MAINFRAMES

7934



7633



7623A

CONTENTS

7934 Fast Storage 259
7633/R7633 Multimode Storage . . 261
7623A/R7623A Multimode Storage 261
Nonstorage Mainframes 248
Plug-Ins 264
High-Performance Digitizing Mainframes 353

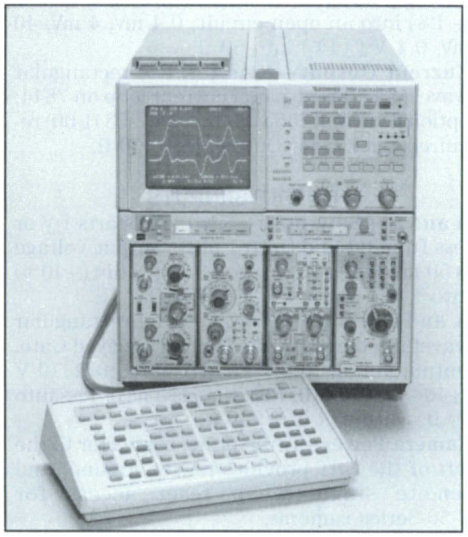
A Selection of Storage Modes

7000-Series CRT-storage mainframes offer a selection of storage modes and features:

- Bistable—For long view time
- Fast Bistable—Captures fast single or multiple events
- Variable Persistence—High-contrast displays
- Fast Variable Persistence—Provides maximum stored writing rate

Selection of Writing Speeds

CRT-storage mainframes in the 7000 Series offer a full selection of stored writing speeds from ≈0.03 cm/μs for mechanical, spectrum analysis, or TDR applications, to 4 cm/ns for capturing fast single events such as high-speed digital logic.

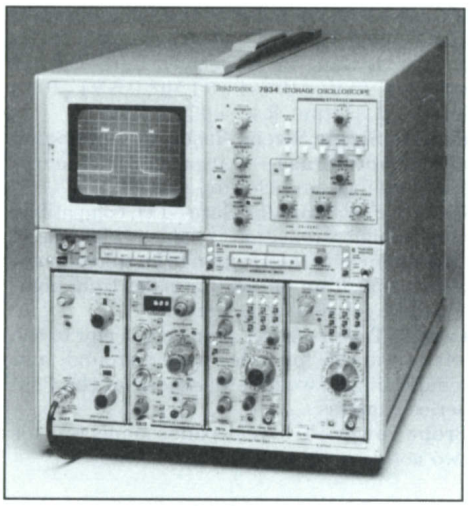


7854 Digital Storage (400-MHz Waveform Processing).

7000-SERIES STORAGE SELECTION GUIDE

Features	7934	7633/R7633	7623A/R7623A
Bandwidth	500 MHz	100 MHz	100 MHz
Maximum Sweep Rate	500 ps/div	5 ns/div	5 ns/div
Rise Time	700 ps	3.5 ns	3.5 ns
Stored Writing Speed	4000 cm/μs	1000 cm/μs	135 cm/μs
Storage Mode			
Bistable	✓	✓	✓
Fast Bistable	✓	✓	✓
Variable Persistence	✓	✓	✓
Fast Variable Persistence	✓	✓	✓
Prices Begin At*1	$13,620	$9,950/$10,500	$7,895/$8,385

*1 *Price does not include plug-in.*



7934

- **DC to 500-MHz Bandwidth**
- **700-ps Single-Shot Rise-Time Storage Capability**
- **4000-cm/μs Stored Writing Speed**
- **500-ps/Div Fastest Calibrated Sweep Rate**
- **Multimode Storage Flexibility**
- **Wide Selection of Plug-In Amplifiers and Time Bases**

TYPICAL APPLICATIONS

Laser Research
High Speed Logic
ESD Testing
Data Base Analysis

See 7000-Series Reference section for available Application Notes.

The 7934 Storage Oscilloscope is designed for fast single-shot, low-repetition rate, and high-speed pulse analysis. The 7934 captures the most difficult types of signals for stored viewing and analysis. Capabilities include storing unexpected transient pulses common in power-generation and nuclear-test studies, high-frequency bursts occurring at low-repetition rates, and fast pulses in applications ranging from lasers to high-speed ECL design.

A 4000-cm/μs storage writing rate, 700-ps rise time, and 500-MHz bandwidth ensure undistorted capture and clear display of the fastest waveform details.

The 7934 stores single-shot rise times to 700 ps, 3.6-cm high, at eight-divisions amplitude, in the reduced-scan mode. The 7934's mainframe bandwidth is 500 MHz. The system bandwidth may vary from 80 MHz to 500 MHz, depending on the plug-in selected.*[1]

*[1] *High-gain differential amplifiers offer very high gain at lower bandwidths.*

The instrument has four storage modes: Bistable, Variable Persistence, Fast Bistable, and Fast Variable Persistence.

Bistable provides stored displays with long (30 minute) view time.

Variable Persistence gives high-contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, variable persistence provides continuous bright displays of new information as old information fades from the CRT.

Fast Bistable increases bistable writing speed to 350 cm/μs (reduced scan).

Fast Variable Persistence provides the maximum stored writing speed of 4000 cm/μs (reduced scan). View time is at least 30 seconds.

The 7934 also offers Store Off for conventional oscilloscope use. . . Multitrace Delay to adjust view time before the next stored trace in Fast transfer. . . Storage Level for adjustable writing speed. . . Save to prevent display erasure and provide up to 30-times extension of viewing time in the variable persistence modes. . . Auto Erase with time interval selection to more than 10 seconds between erasures.

The 7934 has four plug-in compartments with pushbutton selection of active compartments and trigger sources. There is also a choice of over 30 Tektronix 7000-Series plug-in amplifiers, time bases, and special-purpose plug-ins. This provides the flexibility to design a complete measurement system to fit a specific need, and quickly change it when measurement needs change.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments. Compatible with all 7000-Series plug-ins.
Bandwidth—500 MHz with 7A29 Amplifier plug-in.
Rise Time—700 ps or less with 7A29 Amplifier plug-in (1.1 ns at 10 mV).
Bandwidth, Rise Time, and Deflection Factor—Determined by plug-in unit. See 7000-Series Vertical System Specifications.
Display Modes—Left, Alt, Add, Chop, Right. Chopped-mode repetition rate is ≈1 MHz.
Trace Separation—In dual-sweep modes, positions B trace at least four divisions above or below the A trace.
Delay Line—Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

HORIZONTAL SYSTEM

Channels—Two right-hand plug-in compartments. Compatible with most 7000-Series plug-ins. 7000-Series vertical amplifiers and special plug-ins may also be used.
Bandwidth—DC to at least 1 MHz.
Display Modes—A, Alt, Chop, B. Chopped-mode repetition rate is ≈200 kHz.
Fastest Calibrated Sweep Rate—500 ps/div.
X-Y Mode—Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

CRT AND DISPLAY FEATURES

CRT—Internal variable illuminated graticule. 8×10 division (0.9 cm/div) graticule in full scan and 8×10 division (0.45 cm/div) in reduced scan. Accelerating potential is ≈10 kV full-scan mode, and 12 kV in reduced scan-mode. GH (P31) phosphor standard.
Auto Focus—Maintains CRT focus following changes in display intensity after focus control has been set.
Beam Finder—Aids in locating an off-screen signal.
CRT Display Modes—Store Off, Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence (full and reduced scan).
Auto Erase—Continuously variable from <1 s to >10 s.
Multitrace Delay—Adjusts the transfer cycle time in the fast transfer modes. Continuously variable from <1 s to >4 s.
Persistence—(Variable-Persistence Mode only) Controls rate of continuous erasure of the variable-persistence and fast variable-persistence stored displays.
Save—Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in variable-persistence modes.
External Z-Axis Input—2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

CALIBRATOR

Voltage Output—Square wave, positive going from ground.
Voltage Range—40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within 0.25%.
Current Output—40-mA square wave with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS

+Sawtooth—Starts 1 V or less from ground into 1 MΩ. Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.
Bandwidth—Determined by vertical plug-in. See 7000-Series Reference section.
Vertical-Signal Out—Selected by B Trigger Source switch. Output voltage is 0.5 V (±10%) into 1 MΩ, 25 mV (±10%) into 50 Ω. Output R is ≈950 Ω.

Storage Writing Speed

Full Scan (Center 6×8 div at 0.9 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	270 cm/μs (300 div/μs)	45 cm/μs (50 div/μs)	1.8 cm/μs (2 div/μs)	0.027 cm/μs (0.03 div/μs)
View Time	30 s*1	30 min	30 s*1	30 min
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

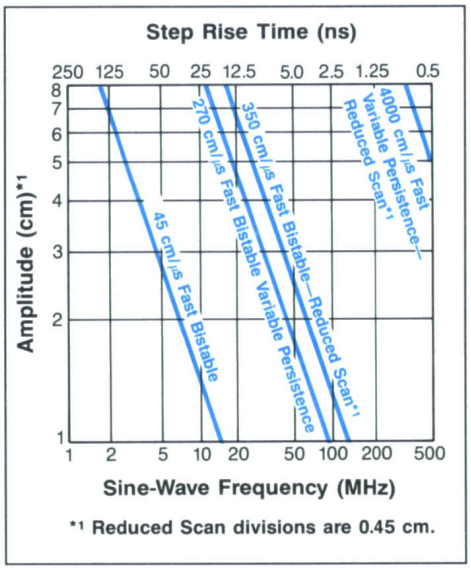
Reduced Scan (Center 8×10 div at 0.45 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	4000 cm/μs (8800 div/μs)	350 cm/μs (776 div/μs)	5.4 cm/μs (12 div/μs)	0.09 cm/μs (0.2 div/μs)
View Time*1	30 s*1	30 min	30 s*1	30 min
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

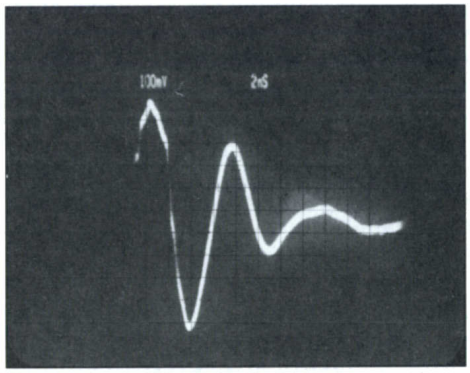
*1 *View times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

Fast Variable Persistence Writing Speed

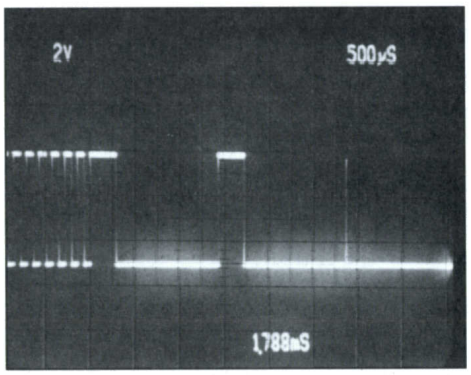
Scan Mode	Sweep Speed	Peak-to-Peak Sine Wave	Step Response
Reduced Scan 8,800 div/μs (0.45 cm/div	≥1 ns/div	7.1 div 325 MHz	7.7 div 1.07 ns
		8 div 290 MHz	8 div 1.2 ns
Full Scan 300 div/μs (0.9 cm/div)	≥ 10 ns/div	3.2 div 30 MHz	3 div 10 ns
		6.4 div 15 MHz	5 div 16.6 ns



Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.



In laser research—The 7934 captures a laser primary and reflected pulse using Fast Variable-Persistence storage (reduced scan) and two 7A29 plug-ins in ADD mode.



Glitch Capture—The 7934 captures a glitch (near the 8th) using a 7A29 plug-in and variable-persistence storage.

+Gate—Positive pulse of the same duration and coincident with sweep selectable from A Gate, B Gate, or A Delayed Gate. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω.

Remote Single Sweep Reset, Remote Save, and Remote Erase—Rear-panel BNC connector inputs, ground-closure activated.

Remote Fast Transfer Gate—TTL compatible. Low-to-high transition enables high-speed target to receive information to be stored; high-to-low transition initiates transfer from high-speed target to storage target.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

Probe Power—Two rear-panel connectors for two active probes.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 132 V ac and 180 to 250 V ac.

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—230 W.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.

Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in.) p-p displacement 10 to 55 to 10 Hz in one minute cycles. Held for three minutes at 55 Hz, referenced to MIL-T 28800C.

Humidity—Operating/Nonoperating: 95%, 5 cycles (120 hours), referenced to MIL-E-16400F.

Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks, referenced to MIL-T-28800C.

EMC Capabilty—Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety—UL listed (UL 1244) and CSA certified (CSA 556B); meets VDE 0871 Class B.

PHYSICAL CHARACTERISTICS

	Cabinet	Rackmount
Dimensions	**mm**	**in.**
Width	305	12.0
Height	345	13.6
Depth	622.5	24.5
Weight ≈	**kg**	**lb**
Net, without plug-ins	17.2	37.8
Shipping, without plug-ins	21.6	47.6

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7934 Storage Oscilloscope **$13,620**
Includes: Installed gray CRT filter (378-0625-02); green CRT filter (378-0625-08); power cord (161-0066-00); operator's manual (070-5879-00).

OPTIONS

Option 02—X-Y Mode Phase Correction. Adds X-Y delay compensation network to equalize the signal delay between either vertical compartment and the B horizontal compartment. **+$260**

Option 03—EMC capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

CONVERSION KITS

X-Y Mode Phase Correction—
Order 040-0942-01 **$210**

EMC Capability—
Order 040-1195-00 **$375**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

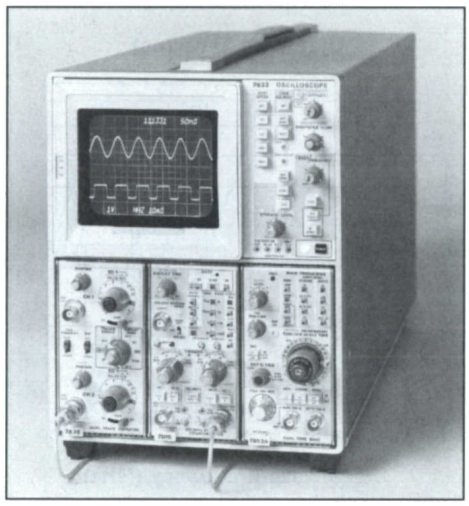
OPTIONAL ACCESSORIES

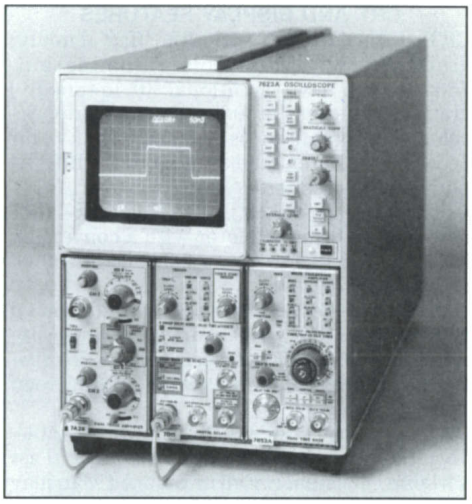
Service Manual—
Order 070-5880-00 **$30**

Cradle Mount Adaptor—For rack-mounting. Order 040-0560-00 **$535**

Recommended Plug-Ins, Probes, and Cameras—See 7000-Series Reference section.

Recommended Cart—K213 Option 12, see Instrument/Cart Compatibility chart in Accessories section.





7600 Series

- **DC to 100-MHz Bandwidth**
- **3.5-ns Rise Time**
- **5-ns/Div Fastest Calibrated Sweep Rate**
- **5.25-Inch Rackmount Height**
- **Long View Time**

7633/R7633 Features:

- **1000-cm/μs Stored Writing Speed**
- **Multimode Storage**

TYPICAL APPLICATIONS

Digital Design
Destructive Testing
Communications

7623A/R7623A Features:

- **135-cm/μs Stored Writing Speed**
- **Multimode Storage**

TYPICAL APPLICATIONS

Ultrasonics
Power-Supply Design
Component Testing

See 7000-Series Reference section for available Application Notes.

The 7633 Storage Oscilloscope provides 2200-div/μs (1000 cm/μs) stored writing speed and 100-MHz bandwidth. The instrument has three display modes— store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The maximum writing speed of 1000 cm/μs (using the center 8×10 reduced-scan divisions, 0.45 cm/div) is achieved in reduced-scan mode.

This multimode storage instrument allows for retention and viewing of fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms.

The 7623A/R7623A Storage Oscilloscopes have all the features and performance of the 7633/R7633 except the reduced-scan mode.

The R7633/R7623A require only 5.25 inches of rack height in a standard 19-inch rack. They are fan cooled and come complete with slide-out chassis tracks.

CHARACTERISTICS

Characteristics are common to the 7633/R7633 and 7623A/R7623A unless otherwise noted.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments. Compatible with all 7000-Series plug-ins. See 7000-Series Reference section.
Bandwidth—Determined by mainframe and plug-in unit. See 7000-Series Reference section.
Rise Time—Determined by mainframe and plug-in unit. See 7000-Series Reference section.
Deflection Factor—Determined by plug-in unit. See 7000-Series Reference section.
Display Modes—Left, Alt, Add, Chop, Right. Chopped-mode repetition rate is ≈1 MHz.
Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channel—One right-hand plug-in compartment. Compatible with all 7000 Series plug-ins. See 7000-Series Reference section.
Bandwidth—DC to at least 2 MHz.
Fastest Calibrated Sweep Rate—5 ns/div.
X-Y Mode—Phase shift <2° from dc to 35 kHz.

CRT AND DISPLAY FEATURES

CRT—Internal 8×10-division (0.9 cm/div) graticule with variable illumination. 7633/R7633 have additional (0.45 cm/div) graticule used in the reduced-scan mode. Accelerating potential is 8.5 kV (10 kV for 7633/R7633 in reduced-scan mode). GH (P31) phosphor is standard.

Option 01, Without CRT Readout—CRT readout can be added later with a conversion kit (040-0748-01 for 7633/7623A, 040-0759-03 for R7633/R7623A).

Autofocus—Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder—Aids in locating an offscreen signal.

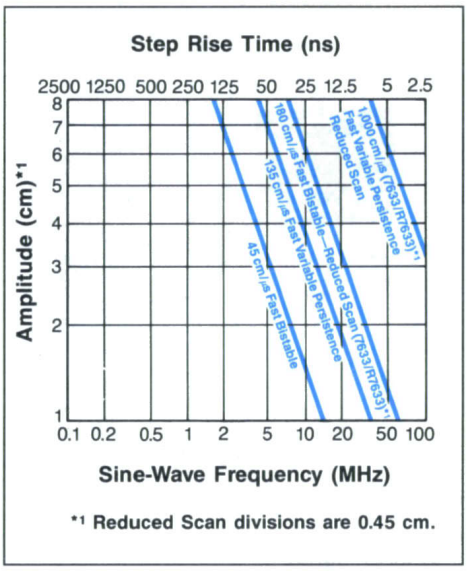
CRT Display Modes—Nonstore, Bistable, Variable Persistence, Fast Bistable, Fast Variable Persistence. Full or reduced scan may be selected on the 7633/R7633 in all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

Auto Erase—Continuously variable to >10s.

Save—Prevents accidental erasure of display and extends view time up to 30 times longer in all modes.

Persistence—(Variable) Controls rate of continuous erasure of stored displays.

External Z-Axis Input—2 V p-p for useful intensity range from dc to 2 MHz. Intensity range diminishes to 20% of full range at 10 MHz. Positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.



Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.
**1 Reduced Scan divisions are 0.45 cm.*

Storage Writing Speed

Full Scan

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/µs	45 cm/µs	0.45 cm/µs	0.03 cm/µs
View Time	30 s*1	30 min minimum	30 s*1	30 min minimum
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

Reduced Scan

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	1000 cm/µs	180 cm/µs	1.35 cm/µs	0.09 cm/µs
View Time*1	30 s*1	30 min minimum	30 s*1	30 min minimum
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

**1 These times are at full stored-display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-Peak Sine Wave	Step Response
Reduced Scan 2200 div/µs (0.45 cm/div)	≥5 ns/div	7.1 div 100 MHz	7.7 div 3.5 ns
		8 div 89 MHz	8 div 3.7 ns
Full Scan 150 div/µs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz	3 div 20 ns
		6.4 div 7.5 MHz	5 div 33 ns

CALIBRATOR

Voltage Output—Rectangular waveshape, positive going from ground (dc voltage available when selected by internal jumper).

Voltage Ranges—40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15 to 35°C); within 2% (0 to 50°C). Repetition rate is ≈1 kHz.

Current Output—40-mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground-pin jacks. Output R is ≈450 Ω.

OUTPUTS/INPUTS

+Sawtooth—Sawtooth starts 1 V or less from ground into 1 MΩ. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+Gate—Positive-going waveform of the same duration and coincident with sweep selectable from main, delay, or auxiliary gate. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%,) into 1 MΩ. Rise time is 20 ns or less into 50 Ω. Output R is 950 Ω within 2%.

Vertical Signal Out—Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is 950 Ω within 2%. Bandwidth is determined by vertical plug-in. See 7000-Series Reference section.

Camera Power Output—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

External Single-Sweep Reset—Ground closure; rear panel BNC input to reset sweep.

Remote Erase—Rear-panel BNC connector inputs, ground-closure activated.

POWER REQUIREMENTS

Line-Voltage Ranges—100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick change jumpers.

Line Frequency—50 to 60 Hz.

Option 05, Line Frequency Change (50 to 400 Hz)—Converts 50 to 400 Hz operation.

Maximum Power Consumption—180 W, 2.0 A at 115-V line, 60 Hz. Fan cooling is provided for all models.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.
Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in.) p-p displacement 10 to 55 to 10 Hz in one minute cycles. Held for three minutes at 55 Hz (MIL-T-28800B).
Humidity—Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.
Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks (MIL-T-28800C).
EMC Capability—Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.
Safety—UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	221	8.7	483	19.0
Height	305	12.0	135	5.3
Depth	597	23.5	566	22.3
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	13.6	30.0	14.5	32.0
Shipping	19.0	42.0	28.2	62.0

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7633 Storage Oscilloscope $9,950
Includes: 20-in. two-pin-to-BNC cable (175-1178-00); green CRT filter (378-0625-08); power cord (161-0066-00); instruction manual (070-1767-00).
R7633 Storage Oscilloscope $10,500
Includes: Same as 7633 plus rackmounting hardware.
7623A Storage Oscilloscope $7,895
Includes: Same as 7633, instruction manual replaced with 070-1685-00.
R7623A Storage Oscilloscope $8,385
Includes: Same as 7633 plus rackmounting hardware, instruction manual replaced with 070-1685-00.

OPTIONS

Option 01—Without CRT Readout. NC
Option 03—EMC capability. Adds special shielding for protection to the instrument when operated in severe EMI environments.
(7633/7623A) +$395
(R7633/R7623A) +$375
Option 05—Line Frequency Change (50 to 400 Hz). +$315
Option 08—(7633/7623A only) Protective Panel Cover. +$115
Option 23—(7633/7623A only) VDE RPM Mark. +$50

CONVERSION KITS

CRT Readout—
(7633/7623A) Order 040-0748-02*[1]
(R7633/R7623A) Order 040-0759-04 $800
EMC Capability—
(7633/7623A) Order 040-0663-01 $485
(R7633/R7623A) Order 040-0678-01 $395
Power Supply—To light plug-in pushbuttons. Order 040-0686-01 $90

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

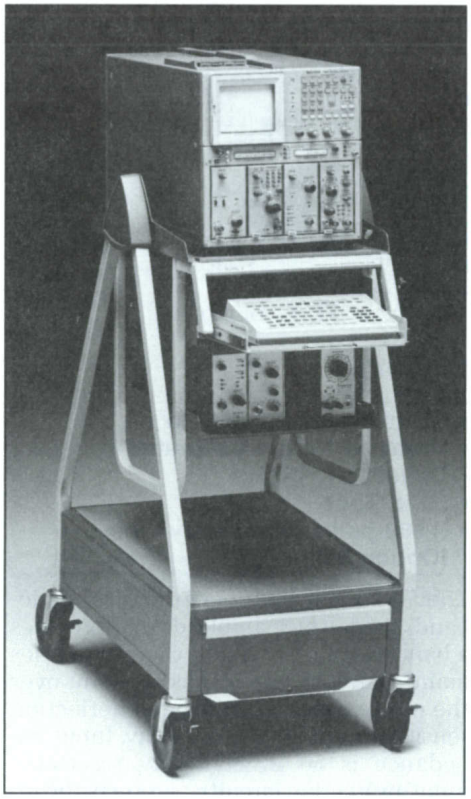
[1] To order, contact your local sales office.

OPTIONAL ACCESSORIES

Recommended Plug-Ins—See 7000-Series Reference section.
Recommended Probes—See 7000-Series Reference section.

RECOMMENDED CARTS

K213 Opt 12—(7633/7623A) See Instrument/Cart Compatibility chart in Accessories section.
K217—(R7633/R7623A) See Instrument/Cart Compatibility chart in Accessories section.

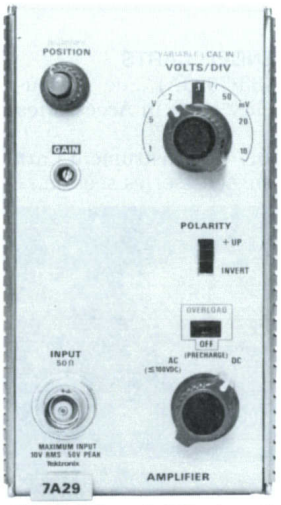


K213 cart shown with optional plug-in storage and keyboard drawer (Option 22).

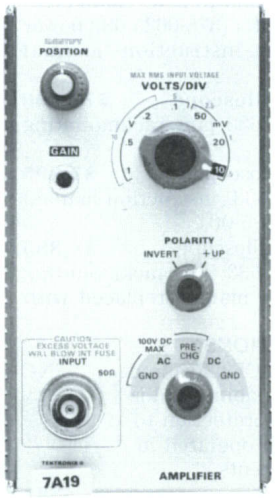
RECOMMENDED CAMERAS

C-53P—General purpose. See 7000 Series Reference section and Camera Reference section. $1,990
C-5C—Option 01—Low cost. See 7000-Series Reference section and Camera Reference section. $465
A6902B—
Allows high CMRR differential, floating, and high-voltage measure ments safely. See Accessories section. $1,885

7000-SERIES PLUG-INS



7A29 DC to 1-GHz Amplifier



7A19 DC to 600-MHz Amplifier

7A29

- **DC to 1-GHz Bandwidth**
- **10-mV to 1-V/Div Calibrated Deflection Factors**
- **50-Ω Input**
- **±500-ps Variable Delay Line (Option 04)**

The 7A29 is a high-performance, wideband, single-trace amplifier that provides a bandwidth of 1 GHz in the 7100-Series mainframes. Bandwidth is constant over the entire range of calibrated deflection sensitivities of 10 mV to 1 V/div. Input impedance is 50 Ω. Manually resettable input-protection circuitry protects the input against most common overloads. Polarity of the display is selectable by a front-panel switch. An optional variable delay line (front-panel adjustable) permits matching the transit time of two 7A29s and/or probes to better than 10 ps.

CHARACTERISTICS

Bandwidth—DC Coupled: 1 GHz (10 mV to 1 V/div).
Deflection Factor—Calibrated: 10 mV to 1 V/div in seven steps (1 2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated: Variable continuously between steps and a maximum of at least 2.5 V/div (with some bandwidth reduction).
Input Z—50 Ω.
AC Coupling—−3 dB at 1 kHz or less from a 50-Ω source.
Option 04, Variable Signal Delay—Permits matching the transit time of two preamps and probes to better than 10 ps. Range is ±500 ps.
Maximum Input Voltage—DC Coupled: 50 or 10 V RMS (whichever is less). AC Coupled: 100 V additional.
DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 0.04 div/°C or less.
Input Protection—Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated and has manual reset.

ORDERING INFORMATION

7A29 Amplifier $3,540
Includes: Instruction manual (070-2320-00).
Option 04—Variable Signal Delay. +$435

7A19

- **DC to 600-MHz Bandwidth**
- **10-mV to 1-V/Div Calibrated Deflection Factors**
- **50-Ω Input**
- **±500-ps Variable Delay Line (Option 04)**

The 7A19 is a high-performance, wideband, single-trace amplifier that provides a bandwidth of 600 MHz in the 7100-Series mainframes. Bandwidth is constant over the entire range of calibrated deflection sensitivities of 10 mV to 1 V/div. Input impedance is 50 Ω. An optional variable delay line (front-panel adjustable) permits matching the transit time of two 7A19s and/or probes to better than 50 ps.

CHARACTERISTICS

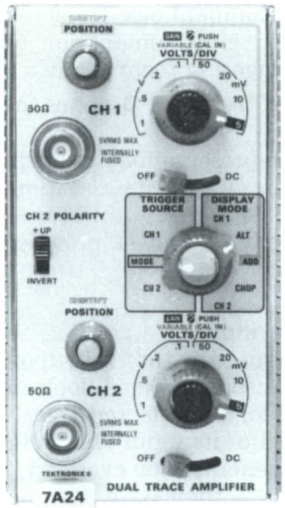
Bandwidth—DC Coupled: 600 MHz (10 mV to 1 V/div).
Deflection Factor—Calibrated: 10 mV to 1 V/div in seven steps (1-2-5 sequence). Accuracy is within 3%.
Input Z—50 Ω.
Option 04, Variable Signal Delay—Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.
Maximum Input Voltage—DC Coupled: 50 or 10 V RMS (whichever is less). AC Coupled: 100 V additional.
DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 100 μV/°C or less.

ORDERING INFORMATION

7A19 Amplifier $3,010
Includes: Instruction manual (070-2129-00).
Option 04—Variable Signal Delay. +$435

CONTENTS

Amplifiers
7A29,7A19 Wideband Single Channel 264
7F10 Optical-Electrical Converter 267
7A24,7A26 Dual Trace 265
7A18A Dual Trace 266
7A42 Four-Channel Logic Triggered 266
7A13 Differential Comparator 268
7A22 Differential 269
Curve Tracer
7CT1N 270
Time Bases
7B80 Delayed 270
7B85 ΔDelaying 270
7B92A Dual 272
7B10 Single 273
7B15 ΔDelaying 273
7B53A Dual 274
7B50A Single 274
Digital
7D15 Counter/Timer 276
7D20 Programmable Digitizer . . . 368
Spectrum Analyzers
7L14 1.8-GHz Plug-In 277
7L12 1.8-GHz Plug-In 277
7L5 5-MHz Plug-In 277
Sampling
Decision Tree and Tutorial 278
7S14 Dual-Trace Delayed-Sweep Sampler 280
7S12 TDR Sampler 281
7S11 Sampling Unit 282
7T11A Sampling Sweep Unit 282
Sampling Heads
7M11 Delay Line 283
S-1 350-ps Rise Time 283
S-2 75-ps Rise Time 283
S-3A 350-ps Rise Time 284
S-4 25-ps Rise Time 284
S-5 1-ns Rise Time 284
S-6 30-ps Rise Time 285
S-51 Trigger-Countdown Head . . . 285
S-52 Pulse-Generator Head 285
S-53 Trigger-Recognizer Head . . . 286
S-54 Pulse-Generator Head 286



7A24 DC to 400-MHz Amplifier

7A24

- **DC to 400-MHz Bandwidth**
- **5-mV to 1-V/Div Calibrated Deflection Factors**
- **50-Ω Input**

The 7A24 is a high-performance, wide-band, dual-trace amplifier that provides 400-MHz bandwidth in the 7100-Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities from 5 mV to 1 V/div. Input impedance is 50 Ω. The 7A24 features five operating modes, trigger-source selectability, and trace identify.

CHARACTERISTICS

Bandwidth—DC Coupled: 400 MHz (5 mV to 1 V/div).
Deflection Factor—Calibrated: 5 mV to 1 V/div in eight steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 5 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 2.5 V/div.
Input Z—50 Ω within 0.5%;

VSWR

	≤1.25	DC to 350 MHz
5 mV–20 mV	≤1.40	350 to 400 MHz
50 mV–1 V	≤1.20	DC to 400 MHz

Maximum Input Voltage—DC Coupled: 5 V RMS.
DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one-hour warm-up.
Displayed Noise—0.7 div or less at 5 mV/div (with a 7900 Series mainframe).
Common-Mode Rejection Ratio—At least 10:1, dc to 50 MHz.

ORDERING INFORMATION

7A24 Amplifier **$2,760**
Includes: Instruction manual (070-1485-00).

7A26

- **DC to 200-MHz Bandwidth**
- **5-mV to 5-V/Div Calibrated Deflection Factors**
- **1-MΩ Input**

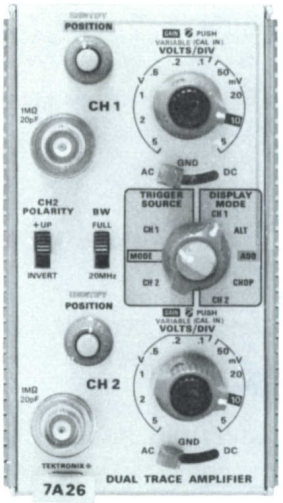
The 7A26 is a dual-trace amplifier that provides a bandwidth of 200 MHz in the 7900- and 7100-Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications. The 7A26 features five operating modes, trigger-source selectability, and trace-identify.

CHARACTERISITICS

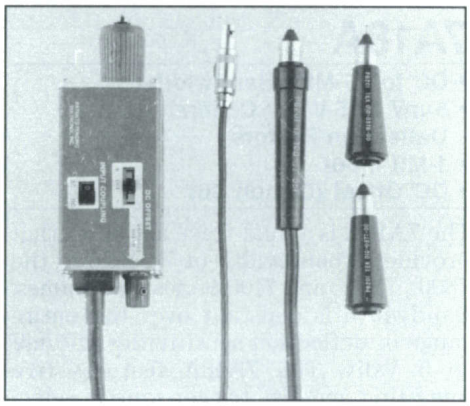
Bandwidth—DC Coupled: 200 MHz (5 mV to 5 V/div). AC Coupled: 10 Hz or less to 200 MHz (5 mV to 5 V/div).
Deflection Factor—Calibrated: 5 mV to 5 V/div in ten steps (1-2 5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.
Input R and C—1 MΩ within 2%; ≈20 pF.
Maximum Input Voltage—DC Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. AC Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.
DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 division in any one minute after one-hour warm up.
Displayed Noise—0.1 div or less at 5 mV/div (with a 7900-Series mainframe).
Common-Mode Rejection Ratio (Add, CH 2 Invert)—At least 10:1, dc to 50 MHz.

ORDERING INFORMATION

7A26 Amplifier **$2,470**
Includes: Instruction manual (070-1484-01).



7A26 DC to 200-MHz Amplifier



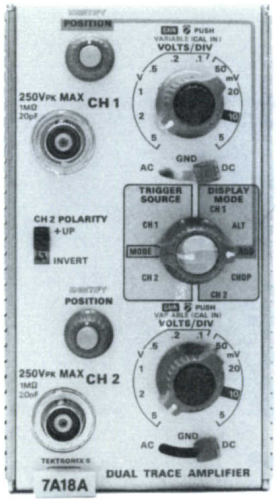
P6201 FET Probe

- **DC to 900-MHz Bandwidth**
- **50-Ω or 1-MΩ Inputs**

The P6201 is an active FET probe that provides unity gain and dc to 900-MHz bandwidth. The low probe-tip capacitance permits coupling of high-frequency signals to an oscilloscope with minimum loading on the circuit being tested. Plug-in attenuator heads provide higher input resistance and reduced input capacitance. Refer to the Accessories section for additional characteristics.

ORDERING INFORMATION

P6201 1X, FET Probe **$1,250**



7A18A DC to 75-MHz Amplifier.

7A18A

- **DC to 75-MHz Bandwidth**
- **5-mV to 5-V/Div Calibrated Deflection Factors**
- **1-MΩ Input**
- **DC Offset (Option 06)**

The 7A18A is a dual-trace amplifier that provides a bandwidth of 75 MHz in the 7800-, 7900-, and 7100-Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV to 5 V/div. The 7A18A features five operating modes, trigger-source selectability, and a trace-identify function.

CHARACTERISTICS

Bandwidth—DC Coupled: 75 MHz (5 mV to 5 V/div). AC Coupled: 10 Hz or less to 75 MHz (5 mV to 5 V/div).
Deflection Factor—Calibrated: 5 mV to 5 V/div in ten steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 10 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.
Input R and C—1 MΩ within 2%; ≈20 pF.
Maximum Input Voltage—DC Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. AC Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.
DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 0.01 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one-hour warm-up.
Displayed Noise—0.06 div or less.
Common-Mode Rejection Ratio (Add, CH 2 Invert)—At least 10:1, dc to 50 MHz.

DC OFFSET OPTION

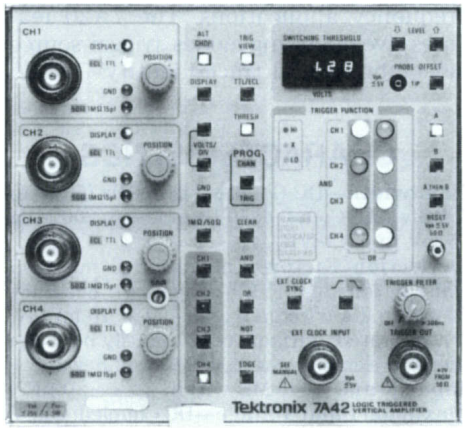
Option 06, DC Offset—Allows small signals riding on larger signals, such as power-supply ripple, to be analyzed. Separate Channel 1 and Channel 2 variable offset controls are concentric with the position controls replacing the identify pushbuttons of the standard 7A18A. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.
Offset Range Display—±200 division maximum, equivalent to ±1 V at 5 mV/div.
Accuracy—When in dc Offset, the deflection accuracy is derated by 1%.

ORDERING INFORMATION

7A18A Amplifier **$1,620**
Includes: Instruction manual (070-4329-00).
Option 06—DC Offset. **+$210**

ISOLATOR

A6902B—For floating and differential measurements. See Accessories section. **$1,885**



7A42

- **Up to 350-MHz Bandwidth (7100 Family)**
- **Four Input Channels**
- **Boolean-Logic Triggering**
- **Nested Trigger Functions**
- **Variable Switching Thresholds**
- **Precise Amplitude and Timing Measurements**
- **External Clock Synchronization**
- **1-MΩ/50-Ω Switchable Inputs**
- **Variable/Bias Offset Probe Compatibility**
- **7000-Series Mainframe Compatible**

The 7A42 Four-Channel Logic-Triggered Vertical Amplifier is a combination of amplifier and triggering technologies.

High-Resolution Analog Display of Digital Signals

Accurate analog representations of digital signals are displayed. A 1-ns rise time with 200-ps or less delay difference between the input channels provides precise, high-resolution timing measurements.

Advanced Triggering

Triggers are generated by the 7A42 upon recognition of user-programmed Boolean combinations of logic levels and transitions at any or all of its input channels. Triggers may be generated on event "A," event "B," or on "A then B."

Trigger-View trace shows where the trigger event occurred and how long it lasted. A trigger filter eliminates requirements that a trigger function remain true longer than the Trigger Filter setting.

External Clock Synchronization

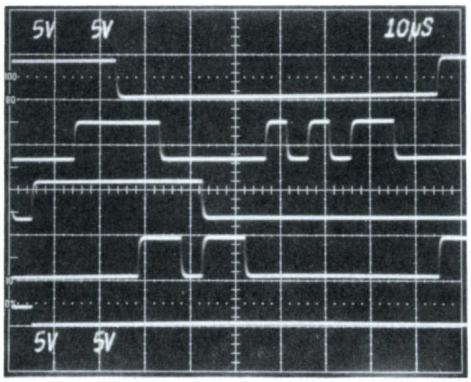
A triggering event can coincide with either a positive or negative transition of an external clock signal.

Special Probe Features

The P6230 is a 1.5-GHz, 450-Ω probe with the ability to place bias voltage at its tip. The P6131 10X high-impedance probe is the recommended probe for TTL, high-speed TTL, and CMOS logic families.

Easy Set-Up

CRT readout of attenuator settings, the display of error messages, and use of multicolored LEDs communicate the status of other 7A42 functions at a glance. A battery backup system preserves the current settings when power is removed.



Up to four logic signals can be displayed by the 7A42 in true analog form. Additionally, the Trigger-View trace provides the ability to view exactly when the programmed Trigger Function is satisfied.

For recommended probes, see 7000-Series Reference section and the Accessories section.
See 7000-Series Vertical-System Specifications chart in 7000-Series Reference section.

CHARACTERISTICS

VERTICAL SYSTEM

Input—Four channels, BNC connectors.
Bandwidth—To 350 MHz maximum. See 7000-Series Reference section.
Input Impedance—Selectable between 1 MΩ and 50 Ω.
Maximum Input Voltage—1 MΩ: 25 V (dc + peak ac). 50 Ω: 5 V RMS during any 1-ms time interval. Active internal protection opens all inputs if overvoltage is applied to any channel.
Differential Delay—200 ps maximum between the four input channels.
Trigger View or External Clock View—Time Coincidence with Channel Display: Trigger View is within 3 ns. External Clock View is within 5 ns.

TRIGGER SYSTEM

External Clock Input—Maximum Voltage Range: +5 to −5 V (dc + peak ac). Pulse Width: TTL level is 20 ns minimum, either pulse transition selected. ECL level is 5 ns minimum, leading edge or 10 ns minimum, trailing edge.
Channel-Edge Sensitivity—Set-Up Time, Channel-to-Channel: 5 ns minimum (time that level-sensitive portion of trigger function must be true before Edge Sensitive Channel transition). Hold Time, Channel-to-Channel: 5 ns minimum (time that level-sensitive portion of trigger function must remain true after Edge Sensitive Channel transition). Set-Up Time, Edge Sensitive Channel: 10 ns minimum (time that level of Edge Sensitive Channel must be stable before transition). Hold Time, Edge Sensitive Channel: 5 ns minimum (time that level of Edge Sensitive Channel must remain stable after transition).
Trigger Out Connector—Output Voltage: 1 V into 50 Ω. Output Impedance: ≈50 Ω. Toggle Frequency: 125 MHz maximum.
Reset Input—Maximum Input Voltage: +5 to −5 V (dc + peak ac). Input Impedance: ≈50 Ω. Logic Zero Level: ≤0.2 V. Logic One Level: ≥0.8 V. Pulse Width: 100 ns minimum. Timing (Post-Reset Inhibit Time to Next Trigger): 10 ns minimum (time from falling edge of Reset to next recognizable event).

Response Time: Reset pulse must lead or be coincident with event recognition to inhibit trigger output. Event recognition must lead the Reset pulse by 10 ns to guarantee trigger output.

BATTERY BACK-UP

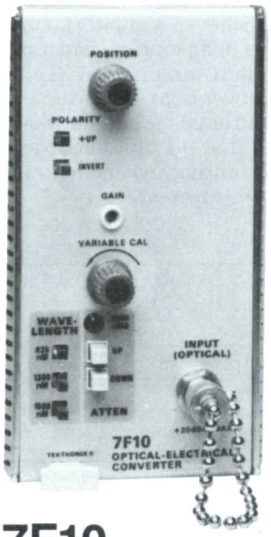
Ni-Cad Battery (3.75 V)—Provides power to preserve front-panel control status a minimum of 200 hours while main power is off. Battery requires about 24 hours to fully charge from discharged condition.

ORDERING INFORMATION

7A42 Logic-Triggered Vertical Amplifier **$5,415**
Includes: Instruction manual (070-4285-00).

OPTIONAL ACCESSORIES

P6230—10X Variable Bias/Offset **$420**
P6131—10X Passive **$140**
KLIPKIT—Provides hands-free connection to integrated circuits. See Accessories section for complete description. Order 013-0197-00. **$46**



7F10 Optical-Electrical Converter

- **Single-Mode/Multimode Fiber Optical Input**
- **700- to 1550-Nanometer Wavelength**
- **10-kHz to 750-MHz Frequency Response**
- **Built-In Optical Attenuator**
- **CRT Readout of Deflection Factor**

The 7F10 single-wide plug-in module is an optical-to-electrical converter for use with either single-mode or multimode fibers. It offers 10-kHz to 750-MHz frequency response and covers the 700- to 1550-nanometer spectrum with a choice of three calibrated wavelengths: 825, 1300, and 1500 nanometers. It is designed for use in the vertical compartments of 7000-Series Oscilloscopes.

The optically coupled 7F10 input goes through a built-in attenuator that provides sixteen calibrated settings for controlling the input-signal level. On the front panel there is an optical overload indicator and pushbuttons to vary the attenuation level. Readout for deflection factor, uncalibrated indication, and polarity invert appears on the CRT.

CHARACTERISTICS

CONVERTER-AMPLIFIER

Optical Input—Diamond 3.5-mm connector, 50/125-μm multimode fiber.
Wavelength—Operates from 700 to 1550 nm continuously with selectable calibrated settings at 825, 1300, and 1500 nm.
Photo Element—Ge-APD.
Maximum Linear Input—+10-mW optical carrier, 70% modulation.
Deflection Factor—16 selectable 2.5-dB steps. Calibrated 1500-nm Wavelength: 2.5 μW/div ±30% at 0-dB attenuation setting. Calibrated 1300-nm Wavelength: 2 μW/div ±30% at 0-dB attenuation setting. Calibrated 850-nm Wavelength: 4 μW/div ± 30% at 0-dB attenuation setting.
Variable Range—At least 4 dB.

Frequency Response

7104/R7103	10 kHz to 750 MHz, ±3 dB
7900 Series	10 kHz to 400 MHz, ±3 dB
7800 Series	10 kHz to 300 MHz, ±3 dB

Position Range—9 divisions each direction from graticule center, within 1 division.

ENVIRONMENTAL

Temperature—Calibration: 20 to 30°C. Operating: 0 to 50°C, to 95%. Nonoperating: −55 to +75°C to 95% humidity.
Altitude—Operating: To 4500 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

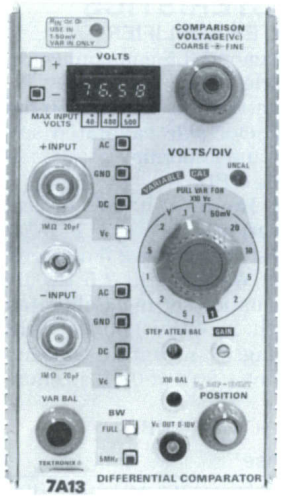
ORDERING INFORMATION

7F10 Optical-Electrical Converter **$7,250**
Includes: Instruction manual (070-6277-00).

OPTIONAL ACCESSORIES

1-m Optical-Fiber Interface Cables*[1]
(Diamond 3.5 to Diamond 3.5)
Order 174-0045-01 **$235**
(Diamond 3.5 to SMA)
Order 174-0524-01 **$160**
(Diamond 3.5 to FC)
Order 174-0527-01 **$200**
(Diamond 3.5 to D4)
Order 174-0528-01 **$235**
(Diamond 3.5 to AT&T Biconic)
Order 174-0530-01 **$195**

*[1] *3-m cables are also available. To order, contact your local Tektronix Sales Office.*



7A13

- **DC to 105-MHz Bandwidth**
- **1-mV to 5-V/Div Calibrated Deflection Factors**
- **1-MΩ Input Switchable to ∞**
- **20,000:1 CMRR**
- **10,000 cm Effective Screen Height**

The 7A13 is a differential-comparator amplifier that provides dc to 105-MHz bandwidth in all the 7100- and 7900-Family instruments. It incorporates a number of features that make it particularly versatile, especially in multitrace combination with other 7000-Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1-mV to 5-V/div deflection-factor range. The bandwidth is selectable to Full or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier, the 7A13 provides a balanced (+ and −) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier, the 7A13 provides an accurate (0.1%) positive or negative internal offsetting voltage of up to 10 V. This precision offset voltage effectively provides a screen height of 10,000 div at 1 mV/div. The offset voltage is also available as an output for external monitoring.

CHARACTERISTICS

Bandwidth—DC Coupled: 105 MHz (1 mV to 5 V/div).

Input R and C—1 MΩ within 0.15%; ≈20 pF. R_{in} ≈ ∞ is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

Deflection Factor—Calibrated: 1 mV to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

Maximum Input Gate Current—0 to +35°C: 0.2 nA or less. +35 to +50°C: 2 nA or less.

DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 2 mV/10° C to 0.2 div/10° C or less (whichever is greater). Drift with Time (Ambient Temperature and Line Voltage Constant): Short term is 1 mV p-p or 0.1 div or less (whichever is greater) over any one-minute interval after 20-minute warm-up. Long term is 1 mV p-p or 0.1 division or less (whichever is greater) during any one-hour interval after 20-minute warm-up.

Signal Range

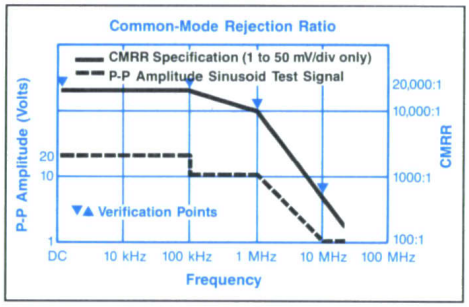
Deflection-Factor Settings	1 mV to 50 mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
Common-Mode Signal	±10 V	±100 V	±500 V
Maximum DC Coupled Input (dc + peak ac at 1 kHz or less)	±40 V	±400 V	±500 V
Maximum AC Coupled Input (dc voltage)		±500 V	

Overdrive Recovery—1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only, regardless of pulse duration.

Displayed Noise (Tangentially Measured)—With X10 Vc In: 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 to 5 mV/div; 0.05 div or less at 10 mV to 5 V/div. With X10 Vc Out: 0.4 div or less at 10 mV to 0.5 V/div.

Internal Comparison Voltage—Range: 0 to ±10 V. Accuracy: ±(0.1% of setting +3 mV). Vc Output R: ≈15 kΩ.

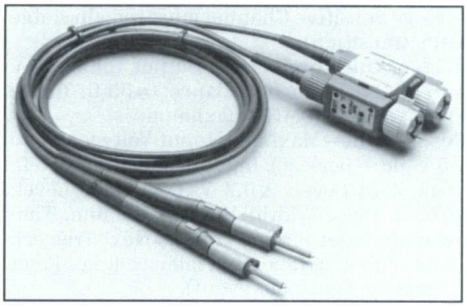
Common-Mode Rejection Ratio—At least 2000:1, 10 mV to 50 mV/div (X10 Vc out) and 0.1 to 5 V/div. AC coupled input at least 500:1 at 60 Hz.



ORDERING INFORMATION

7A13 Amplifier **$3,655**
Includes: Instruction manual (070-1948-00).

For floating measurements, order A6902B Isolator. See Accessories section for complete description.



P6135 10,000:1 CMRR, 10X (Adjustable) with Readout

- **DC to 150-MHz Bandwidth**
- **Low Capacitance**
- **High CMRR**
- **Matched Pair**

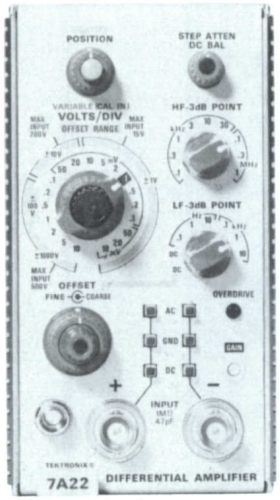
Refer to the Accessories section for additional information.

ORDERING INFORMATION

P6135 Matched Pair of 10X, 1.5-m Differential Probes*[1]

*[1] *Contact your local sales office for ordering information.*

For recommended probes, see 7000-Series Reference section and the Accessories section.
See 7000-Series Vertical-System Specifications chart in 7000-Series Reference section.



7A22 Differential Amplifier

7A22

- **DC to 1-MHz Bandwidth**
- **10-μV to 10-V/Div Calibrated Deflection Factors**
- **1-MΩ Input**
- **100,000:1 CMRR**
- **Selectable Upper and Lower −3 dB Points**
- **DC Offset**
- **10-μV/Hour DC Drift*1**

*1 *With constant temperature. See dc stability specifications.*

The 7A22 is a high-gain differential amplifier well suited for difficult low-amplitude, low-frequency measurements. Selectable high- and low-pass filters help eliminate unwanted noise and drift from the display and from the triggering signal.

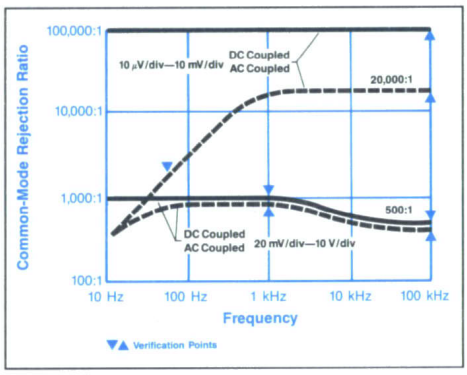
CHARACTERISTICS

Bandwidth—HF: −3 dB point selectable in nine steps (1-3 sequence) from 100 Hz to 3 kHz. Accuracy is within 10% of selected frequency. Rise time is 350 ns ±9% in 1-MHz position. LF: −3 dB point selectable in six steps (1-10 sequence) from 0.1 Hz to 10 kHz. Accuracy is within 12% of selected frequency. The switch also contains dc and dc with Offset positions. AC coupled at input, 2 Hz or less.
Deflection Factor—Calibrated: 10 μV to 10 V/div in 19 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 1 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 25 V/div.
Input R and C—1 MΩ within 1%; ≈47 pF.
Maximum Input-Gate Current (Differentially Measured)—10 μV to 10 mV/div: 40 pA at +25°C; 200 pA at +50° C. 20 mV to 10 V/div: 10 pA at +25°C; 20 pA at +50°C.
Single ended, one-half the differential measurement. Display shift (10 μV/div, ac coupled) is ±4 divisions at +25°C; ±20 divisions at +50°C.

Signal and Offset Range

Deflection-Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-Mode Signal	±10 V	±100 V	±500 V	
Maximum DC Coupled Input (dc + peak ac at 1 kHz or less)	±15 V	±200 V	±500 V	
Maximum AC Coupled Input (dc voltage)	±500 V dc rejection, at least 4×10⁵:1			
DC Offset	+1 to −1 V	+10 to −10 V	+100 to −100 V	+100 to −100 V

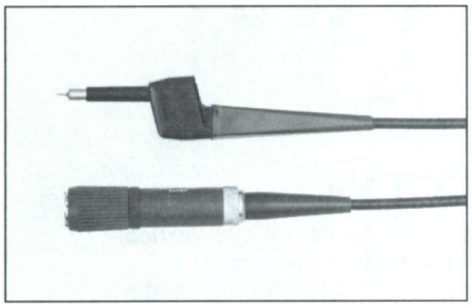
DC Stability—(Line Voltage Constant): 50 μV/°C or less. Drift with Time (Ambient Temperature and Line Voltage Constant): Short term is 5 μV p-p or 0.1 div (whichever is greater) over any one-minute interval after one-hour warm-up. Long term is 10 μV p-p or 0.1 div (whichever is greater) in any one-hour interval after one-hour warm-up.
Displayed Noise—16 μV or 0.1 div (whichever is greater) at maximum bandwidth. Source resistance, 25 Ω or less measured tangentially.
Overdrive Recovery—10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front-panel Overdrive light indicates that an overdrive condition is being approached.



Common-Mode Rejection Ratio (for signals not exceeding common-mode signal range)

ORDERING INFORMATION

7A22 Amplifier **$1,855**
Includes: Instruction manual (070-0931-00).
High CMRR Differential Probes
P6055—Matched pair of probes for maximum CMRR. (See Accessories section for complete P6055 description.) **$540**



P6055

20,000:1 CMRR, 10X With Readout

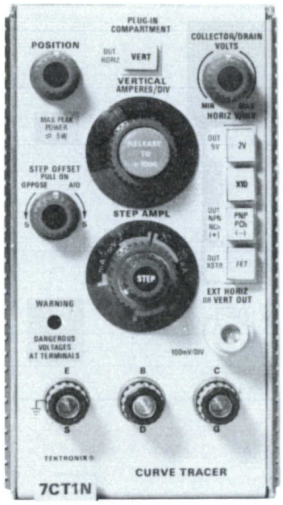
- **DC to 60 MHz**
- **Low Capacitance**
- **High CMRR**
- **Compact Size**

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ±2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

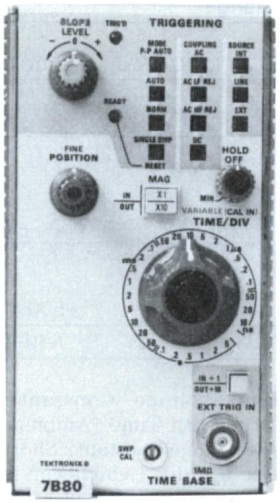
When two P6055 probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provides the best possible system CMRR.

ORDERING INFORMATION

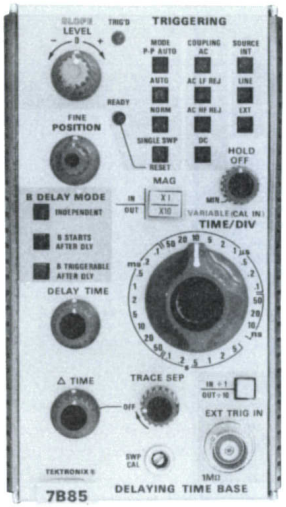
P6055 Matched pair of 10X, 3.5 ft Differential Probes **$540**
Option 01—Single probe with accessories. **−$260**



7CT1N Curve Tracer



7B80 Delayed Time Base



7B85 ΔDelaying Time Base

7CT1N

- **10-nA to 20-mA/Div Vertical-Deflection Factors**
- **0.5-V to 20-V/Div Horizontal Deflection Factors**

The 7CTIN converts your 7000-Series oscilloscope into a semiconductor curve tracer capable of displaying characteristics of small-signal devices to power levels up to 0.5 W. The 7CT1N operates in either the horizontal or vertical compartments of any 7000-Series mainframe. It may be used in conjunction with standard amplifier and time-base plug-in units to display signal waveforms along with characteristic curve families.

For more information on the 7CT1N, see Curve Tracer section.

ORDERING INFORMATION

7CT1N Curve Tracer **$1,870**
Includes: Instruction Manual (070-1247-00).

7B80/7B85

- **1-ns to 5-s/Div Calibrated Time Bases**
- **Triggering to 400 MHz**
- **Variable Trigger Holdoff**
- **Peak-to-Peak Auto Triggering**

7B85 Features:

- **ΔTime Measurements With CRT Readout**
- **Delayed-Time Measurements With CRT Readout**
- **Vertical Trace Separation Between Two Delayed Sweeps**

The 7B80 and 7B85 are horizontal time bases recommended for use with the 7800- or 7900-Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000-Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Each plug-in can be used separately as an independent single time base, or combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (Display Mode) selects normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal-deflection system. This option is appropriate where the user is making Y-T and X-Y measurements, and changing the amplifier frequently from the vertical to the horizontal compartment is not acceptable.

7000-SERIES TIME-BASE SELECTION GUIDE

Performance Feature	7B50A	7B53A	7B80	7B85	7B92A	7B10	7B15
Single time base	✓		✓	✓		✓	✓
Dual time base		✓			✓		
With mixed sweep		✓					
TV Sync Triggering		Opt 05					
Used also as delayed time base			✓			✓	
Delaying sweep				✓			✓
ΔDelay sweep				✓			✓
Display switching					✓		
Prices begin at	$1,320	$2,085	$1,715	$2,140	$3,870	$2,640	$3,000

7000-SERIES TIME-BASE/MAINFRAME RECOMMENDATION

Mainframe	7B50A	7B53A	7B80	7B85	7B92A	7B10	7B15
7104/R7103					✓	✓	✓
7904A/R7903			✓	✓	✓	✓	✓
7844/R7844			✓	✓	✓	✓	✓
7934			✓	✓	✓	✓	✓
7854			✓	✓ *1	✓ *1	✓	✓ *1
7603/R7603	✓	✓					
7633/R7633 7623A/R7623A	✓	✓					

*1 *Single-sweep mode operable for real time only.*

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

MAIN SWEEP

Sweep Rates—Calibrated: 5 s to 10 ns/div in 27 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 1 ns/div. Uncalibrated: Variable is continuous to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy—Measured over the center eight divisions, +15 to +35 °C, in the 7800- or 7900-Series mainframe. Derate accuracies by an additional 1% for 0 to +50 °C.

Time/Div*1	Unmagnified	Magnified
5 to 1 s/div	4.0%	Unspecified
0.5 s to 50 ns/div	1.5%	2.5%
20 to 10 ns/div	2.5%	4.0%

*1 *Fastest calibrated sweep rate is limited by 7600-Series Mainframes.*

Trigger Holdoff Time—Minimum holdoff setting: 2 times Time/Div setting or less for sweep rates 5 s to 1 μs/div; 2 μs or less for sweep rates 0.5 μs to 10 ns/div. Variable extends holdoff through at least 2 sweep lengths for 20-ms/div or faster sweep rates.

ΔTime Range—(7B85 only) 0 to at least 9.0 times Time/Div setting.

ΔTime Accuracy (+15 to +35 °C)—(7B85 only) 0.5 s to 50 ms/div: Within (0.5% of reading +0.1% full scale +1 count)*1. 20 ms to 100 ns/div: Within (0.5% of reading +0.03% full scale +1 count)*1.

*1 *Full scale equals ten times the Time/Div switch setting.*

Trace Separation Range—Functional only in ΔDelay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least three divisions below the first delayed-sweep display.

Delay Time Range—0.2 or less to at least 9.0 times Time/Div setting.

Delay Time Jitter—0.02% or less of Time/Div setting plus 0.1 ns.

TRIGGERING

External Trigger Input—Maximum Input Voltage: 250 V (dc + peak ac). Input R and C: 1 MΩ within 5% and 20 pF within 10%. Level Range (Excluding P-P Auto): At least ±1.5 V in Ext÷1, at least ±15 V in Ext÷10.

7B80 Option 02, X-Y Display Capability—A front-panel switch selects either normal-sweep displays or X-Y displays. In the X-Y mode, the X and Y signals are applied to the inputs of a dual-trace vertical amplifier or two single-trace vertical amplifiers. The X signal is routed via the amplifier/mainframe trigger path to the 7B80 Option 02, and then to the mainframe horizontal amplifier for display.

Single Sweep—Requirements are same as for repetitive signals.

Internal Trigger Jitter—0.1 ns or less at 400 MHz.

Triggering Sensitivity From Repetitive Signals (Auto and Norm Modes)

Coupling	Triggering Frequency Range*1	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 50 MHz	0.3 div	50 mV
	50 to 400 MHz	1.5 div	250 mV
AC LF Rej*2	30 kHz to 50 MHz	0.3 div	50 mV
	50 to 400 MHz	1.5 div	250 mV
AC HF Rej	30 Hz to 50 kHz	0.3 div	50 mV
DC*3	DC to 50 MHz	0.3 div	50 mV
	50 to 400 MHz	1.5 div	250 mV

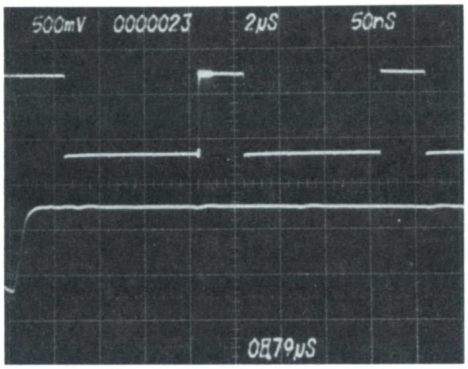
*1 *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

*2 *Will not trigger on sine waves of less than eight divisions Internal, or 3 V External, at or below 60 Hz.*

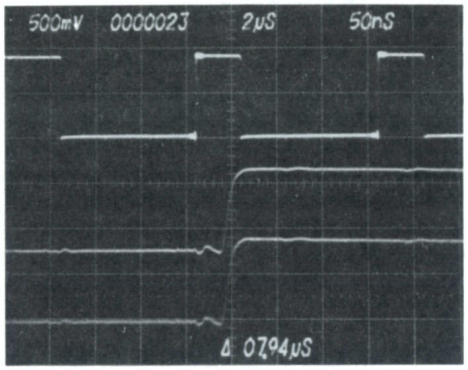
*3 *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Triggering Sensitivity in P-P Auto Mode

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
AC or DC	Low Frequency Response: At least 50 Hz	2.0 div	500 mV
AC or DC	200 Hz to 50 MHz	0.5 div	125 mV
AC or DC	50 to 400 MHz	1.5 div	375 mV



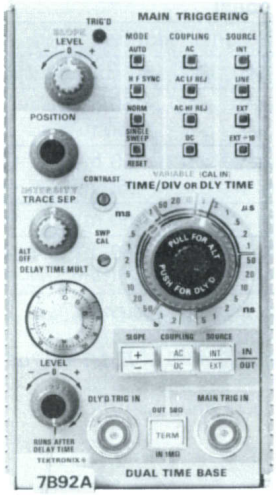
Delaying and delayed sweeps are shown with the mainframe selecting Alt sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.



With the mainframe still selecting Alt sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The Trace Separation knob is used to position the second delayed sweep below the first delayed sweep with up to three divisions of separation.

ORDERING INFORMATION

7B80 Time Base **$1,715**
Includes: Instruction manual (070-1959-00).
Option 02—X-Y Display Capability. **+$105**
7B85 Delaying Time Base **$2,140**
Includes: Instruction manual (070-1961-01).



7B92A Dual Time Base

7B92A

- **0.5 ns to 0.2 s/Div Calibrated Time Base**
- **Triggering to 500 MHz**
- **Alternate Display of Intensified Delaying and Delayed Sweeps**
- **Contrast Regulation Between Delaying and Delayed Sweeps**

The 7B92A Dual Time Base is recommended for use in the 7100-, 7800-, and 7900-Series mainframes. (The 7B92A may be used in all other mainframes at slower sweep speeds. See the selection guides at the front of the 7000-Series Time Base section.)

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep. When operating in the Auto mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

CHARACTERISTICS

DELAYING SWEEP (MAIN SWEEP)

Sweep Rate—Calibrated: 0.2 s to 0.5 ns/div in 27 steps (1-2-5 sequence). Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy—Measured over the center eight divisions in a 7900-Series mainframe:

Time/Div	+15 to +35°C	0 to +50°C
0.2 s to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%
2 to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

Differential Delay-Time Measurement Accuracy*1
Sweep Speed

0.2 s to 0.1 μs/div	Both Delay Time Mult dial settings at 0.5 or greater	±(0.75% of reading +0.25% or greater of full scale*2)
	One or both Delay Time Mult dial settings at less than 0.5	±(0.75% of reading +0.5% of full scale*2 +5 ns)
50 to 10 ns/div	Both Delay Times equal to or greater than 25 ns	±(1% of reading +0.5% of full scale*2)
	One or both Delay Times less than 25 ns	±(1% of reading +1% of full scale*2 +5 ns)

*1 *+15 to +35°C.*
*2 *Full scale is ten times the Time/Div or Delay Time setting. Accuracy applies over the center eight divisions from +15 to +35°C.*

Delay Time Multiplier Range—0 to 9.8 times the Delay Time/Div setting from 0.2 s to 10 ns/div (0 to 1.96 s).

Delay Time Jitter*1

0.2 s to 50 μs/div	0.2% of main sweep time/div switch setting or less
20 μs to 10 ns/div	0.3% of the main sweep time/div switch setting or less

*1 *Not applicable for the first 2% of maximum available delay time (Delay Time Mult dial setting <0.2). Maximum available delay time is ten times the Time/Div or Delay Time switch setting.*

TRIGGERING

Triggering Sensitivity
Auto and Norm Modes

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 20 MHz	0.5 div	100 mV
	20 to 500 MHz	1.0 div	500 mV
AC LF Rej	30 kHz to 20 MHz	0.5 div	100 mV
	20 to 500 MHz	1.0 div	500 mV
AC HF Rej	30 Hz to 50 kHz	0.5 div	100 mV
DC	DC to 20 MHz	0.5 div	100 mV
	20 to 500 MHz	1.0 div	500 mV

HF Sync—Triggering sensitivity is 0.5 div Int or 100 mV Ext, from 100 to 500 MHz for any coupling except AC HF Rej.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

Internal Trigger Jitter—50 ps or less at 500 MHz.

External Trigger Input—Selectable 50-Ω or 1-MΩ inputs (1MΩ is paralleled by ≈20 pF). Maximum Input Voltage: 250 V (dc + peak ac) for 1-MΩ input and 1 W average for 50-Ω input. Level Range: At least ±35 V in Ext÷10.

DELAYED SWEEP

Delayed Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 20 MHz	0.5 div	100 mV
	20 to 500 MHz	1.0 div	500 mV
DC	DC to 20 MHz	0.5 div	100 mV
	20 to 500 MHz	1.0 div	500 mV

Sweep Rate—Calibrated: 0.2 s to 0.5 ns/div in 27 steps (1-2-5 sequence). Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy—Measured over the center eight divisions in a 7900-Series mainframe:

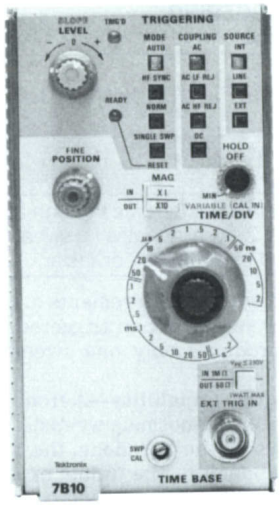
Time/Div	+15 to +35°C	0 to +50°C
0.2 s to 20 ns/div	Within 2%	Within 3%
10 to 5 ns/div	Within 3%	Within 4%
2 to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

Internal Trigger Jitter—50 ps or less at 500 MHz.

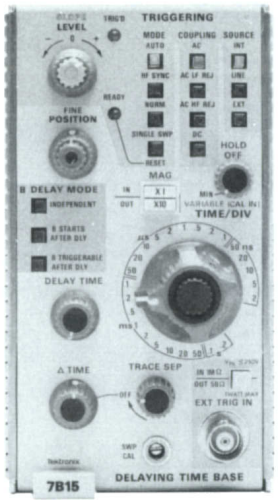
External Trigger Input—Selectable 50-Ω or 1-MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Voltage Input: 250 V (dc + peak ac) for 1-MΩ input, and 1 W average for 50-Ω input. Level Range: At least ±3.5 V in Ext.

ORDERING INFORMATION

7B92A Dual Time Base **$3,870**
Includes: Instruction manual (070-1751-02).



7B10 Delayed Time Base



7B15 ΔDelaying Time Base

7B10/7B15

- **0.2 ns to 0.2 s/Div Calibrated Time Bases**
- **Triggering to 1 GHz**
- **Variable Trigger Holdoff**
- **Auto Triggering**

7B15 Features:

- **ΔTime Measurements With CRT Readout**
- **Delayed Time Measurements With CRT Readout**
- **Vertical Trace Separation Between Two Delayed Sweeps**

The 7B10 and 7B15 are horizontal time bases designed for use with the 7100-Series mainframes to provide optimum bandwidth/sweep-speed compatibility, but may also be used with the 7800- and 7900-Series mainframes. (Each may be used in any slower 7000-Series mainframe with some reduction in sweep accuracy at the fastest sweep speed. See Oscilloscope Reference section.)

Either plug-in can be used separately as an independent, single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

The 7B10 and 7B15 provide Δtime measurement in addition to the standard delay-time display.

Delta time measurement is accomplished simply by manually positioning two intensified zones on the waveform. The time difference between the two zones is displayed in the CRT readout. (See waveform photos in the description of the 7B80/7B85 time bases.) Expansion and overlapping of the two intensified zones is possible to allow very precise setting of the zones to the desired points on the displayed waveform.

CHARACTERISTICS

MAIN SWEEP

Sweep Rates—Calibrated: 2 ns to 0.2 s/div in 25 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div. Uncalibrated: Variable is continuous to at least 2.5 times the calibrated sweep.

Sweep Accuracy—Measured over the center eight divisions, +15 to +35 °C, in a 7100-, 7800-, or 7900-Series mainframe. Derate accuracies by an additional 1% for 0 to +50 °C.

Time/Div*1	Unmagnified	Magnified
0.2 s to 10 ns/div	2%	3%
5 and 2 ns/div	3%	4%

**1 Fastest calibrated sweep rate is limited by 7900-, 7800-, and 7600-Series mainframes.*

Trigger Holdoff Time

	Minimum	Maximum With Variable
0.2 s to 50 ms/div	40 ms	400 ms
20 ms to 2 μs/div	2 times Time/Div Setting	20 times Time/Div Setting
1 to 0.5 μs/div	2 μs	20 μs
0.2 μs to 2 ns/div	2 μs	6 μs

Delay Time Range—(7B15 only) 0.2 or less to at least 9.0 times Time/Div setting.

Delay Time Jitter—(7B15 only) 0.02% of Time/Div setting up through 50 μs/div. 0.03% of Time/Div setting plus 0.1 ns for sweep speeds of 20 μs through 100 ns/div.

ΔTime Range—(7B15 only) 0 to at least 9.0 times Time/Div setting.

ΔTime Accuracy—20 ms to 100 ns/div. Within 0.5% of reading +3 counts.

Trace Separation Range—(7B15 only) Functional only in ΔDelay Time mode when alternating or chopping between time-base units. The second delayed-sweep display can be vertically positioned at least three divisions below the first delayed-sweep display.

Single Sweep—Requirements are the same as for repetitive signals.

Internal Trigger Jitter—30 ps or less at 1 GHz.

HF Sync Mode—250 MHz to 1 GHz, 0.3 div Internal and 0.75 mV External.

External Trigger Input—Maximum Input Voltage: 250 V (dc + peak ac) for 1-MΩ input, 1 W average for 50-Ω input. Input R and C: 1 MΩ within 5% and 20 pF within 10%; for 50-Ω input, 50 Ω within 2%. Level Range: At least ±3.5 V in Ext÷1.

TRIGGERING

Triggering Sensitivity for Repetitive Signals

Coupling	Triggering Frequency Range*1	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 250 MHz	0.5 div	50 mV
	250 MHz to 1 GHz	1.5 div	150 mV
AC LF Rej*2	50 kHz to 250 MHz	0.5 div	50 mV
	250 MHz to 1 GHz	1.5 div	150 mV
AC HF Rej	30 Hz to 40 kHz	0.5 div	50 mV
DC*3	DC to 250 MHz	0.5 div	50 mV
	250 MHz to 1 GHz	1.5 div	150 mV

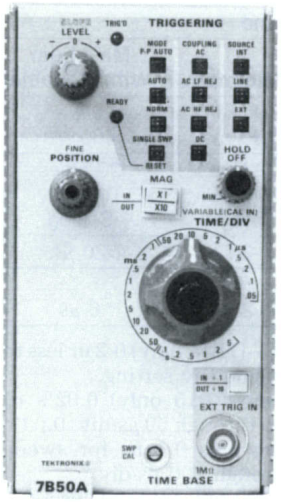
**1 The triggering frequency ranges given here are limited to the −3-dB frequency of the oscilloscope vertical system when operating in the Internal mode.*

**2 Will not trigger on sine waves at or below 60 Hz when amplitudes are less than eight division Internal or 3 V External.*

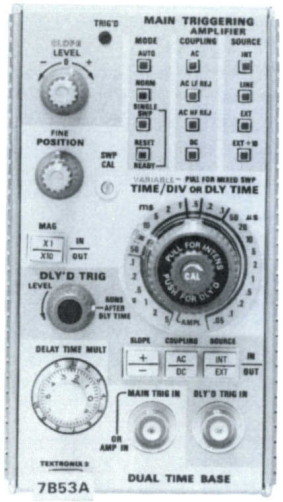
**3 The Triggering Frequency Range for DC Coupling applies to frequencies above 30 Hz when operating in the Auto Triggering Mode.*

ORDERING INFORMATION

7B10 Time Base **$2,640**
Includes: Instruction manual (070-2316-00).
7B15 Delaying Time Base **$3,000**
Includes: Instruction manual (070-2318-00).



7B50A Time Base



7B53A Dual Time Base

7B50A/7B53A

- **5 ns to 5 s/Div Calibrated Time Base**
- **Triggering to 100 MHz (7B53A) and 150 MHz (7B50A)**
- **Variable Trigger Holdoff (7B50A)**
- **P-P Auto Triggering (7B50A)**
- **Single-Sweep Operation**
- **Calibrated Mixed Sweep (7B53A)**
- **TV Sync Separator Triggering (7B53A Option 05)**

The easy-to-use 7B53A and 7B50A Time Bases are recommended for use with 7600-Series mainframes to provide optimum bandwidth/sweep speed compatibility. They may, however, be used in any 7000-Series mainframe to provide sweep rates to 5 ns/div. See Oscilloscope Reference section.

The 7B53A provides normal, intensified delaying, delayed, and mixed sweeps.

CHARACTERISTICS (7B50A)

Sweep Rates—0.05 μs to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy—Measured over center eight divisions, +15 to +35 °C, with any 7000-Series mainframe. Derate accuracies by an additional 1% each for 0 to +50 °C.

Time/Div	Unmagnified	Magnified
5 to 1 s/div	4%	N/A
0.5 s to 0.5 μs/div	2%	3%
0.2 to 0.05 μs/div	3%	4%

TRIGGERING

Trigger Holdoff Time

Minimum	
5 s to 1 μs/div	2 times Time/Div setting or less
0.5 μs to 50 ns/div	2.0 μs or less
Variable	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep until reset.

Option 02, X-Y Display Capability—A front-panel switch selects either normal-sweep displays or X-Y displays. In the X-Y mode, the X and Y signals are applied to the inputs of a dual-trace vertical amplifier or two single-trace vertical amplifiers. The X signal is routed via the amplifier/mainframe trigger path to the 7B50A Option 02, and then to the mainframe horizontal amplifier for display.

Triggering Sensitivity*1

Coupling	Triggering Frequency Range*2	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 50 MHz	0.3 div	50 mV
	50 to 150 MHz	1.5 div	250 mV
AC LF Rej*3	30 kHz to 50 MHz	0.3 div	50 mV
	50 to 150 MHz	1.5 div	250 mV
AC HF Rej	30 Hz to 50 kHz	0.3 div	50 mV
DC*4	DC to 50 MHz	0.3 div	50 mV
	50 to 150 MHz	1.5 div	250 mV

*1 *Auto and Norm modes.*

*2 *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Int mode.*

*3 *Will not trigger on sine waves of less than eight divisions Internal, or 3 V External, at or below 60 Hz.*

*4 *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Triggering Sensitivity (P-P Auto Mode)

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
AC or DC	200 Hz to 50 MHz	0.5 div	125 mV
AC or DC	50 to 150 MHz	1.5 div	375 mV

CHARACTERISTICS (7B53A)

DELAYING SWEEP

Sweep Rate—Calibrated: 50 ns to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

Delay Time Multiplier Range—0 to 10 times the Delay Time/Div setting from 5 s to 1 μs/div.

Differential Delay-Time Measurement Accuracy—5 to 1 s/div: ±1.4% of measurement +0.3% of full scale. 0.5 s to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is ten times the Delay Time/Div setting. Accuracy applies over the center 8 DTM div from +15 to +35 °C.

Delay Time Jitter—0.05% or less of Time/Div setting.

Sweep Accuracy measured over the center eight divisions.

Time/Div	Unmagnified		Magnified	
	+15 to +35°C	0 to +50°C	+15 to +35°C	0 to +50°C
5 to 1 s/div	3%	4%	N/A	N/A
50 ms to 0.5 μs/div	2%	3%	2.5%	4%
0.2 to 0.05 μs/div	3%	4%	3.5%	5%

TRIGGERING

Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 10 MHz	0.3 div	100 mV
	10 to 100 MHz	1.5 div	500 mV
AC LF Rej*1	30 kHz to 10 MHz	0.3 div	—
	150 kHz to 10 MHz	—	100 mV
	10 to 100 MHz	1.5 div	500 mV
AC HF Rej	30 Hz to 50 kHz	0.3 div	100 mV
DC	DC to 10 MHz	0.3 div	100 mV
	10 to 100 MHz	1.5 div	500 mV

*1 *Will not trigger on sine waves of three divisions or less Int or 1.5 V Ext below 120 Hz.*

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only, until reset.

Internal Trigger Jitter—1 ns or less at 75 MHz.

External Trigger Input—Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2% and 20 pF within 2 pF. Level Range: At least +1.5 to −1.5 V in Ext, at least +15 to −15 V in Ext÷10.

DELAYED SWEEP

Sweep Rate—Calibrated: 0.05 μs to 0.5 s/div in 22 steps (1 2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between main, delayed sweep, and variable main sweep holdoff.

Delayed Sweep Gate—Output Voltage: ≈+3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise time: 50 ns or less. Output R is 350 Ω within 10%. Gate is available at the Dly'd Trig In connector when the delayed-sweep-source switch is set to Int.

Sweep Accuracy measured over the center eight divisions.

Time/Div	Unmagnified		Magnified	
	+15 to +35°C	0 to +50°C	+15 to +35°C	0 to +50°C
5 to 0.1 s/div and 0.2 to 0.05 μs/div	4%	5%	4.5%	6%
50 ms to 0.5 μs/div	3%	4%	3.5%	5%

Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 10 MHz	0.3 div	100 mV
	10 to 100 MHz	1.5 div	500 mV
DC	DC to 10 MHz	0.3 div	100 mV
	10 to 100 MHz	1.5 div	500 mV

Internal Trigger Jitter—1 ns or less at 75 MHz.

External Trigger Input—Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2% and 20 pF within 2 pF. Level Range: At least +1.5 to −1.5 V in Ext.

MIXED SWEEP

Sweep Accuracy—Within 2% plus measured main-sweep error. Exclude the following portions of mixed sweep: First 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

EXT HORIZONTAL INPUT

Deflection Factor—10 mV/div within 10% when in Ext, Mag X10; 100 mV/div within 10% when in Ext; 1 V/div within 10% when in Ext÷10.

Bandwidth

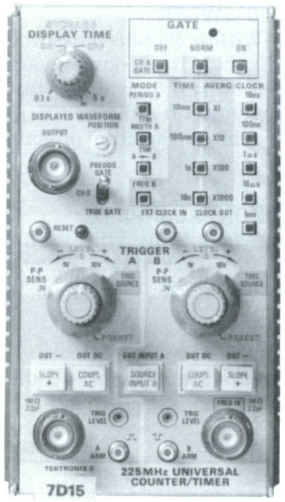
Coupling	Lower −3 dB	Upper −3 dB
AC	40 Hz	2 MHz
AC LF Rej	16 kHz	2 MHz
AC HF Rej	40 Hz	100 kHz
DC	DC	2 MHz

TV SYNC

Option 05, TV Sync Separator Triggering—Permits stable internal line- or field-rate triggering from displayed composite-video or composite-sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or international, with up to 1201-line, 60-Hz field rates. Individual lines may be displayed with delayed-sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system. Option 05 deletes ac line trigger and Ext÷10 from trigger source.

ORDERING INFORMATION

7B53A Dual Time Base **$2,085**
Includes: Instruction manual (070-1342-01).
Option 05—TV Triggering. **+$170**
Includes: Instruction manual (070-1471-00).
7B50A Time Base **$1,320**
Includes: Instruction manual (070-1986-00).
Option 02—X-Y Display Capability. **+$105**



7D15 225-MHz Counter/Timer

7D15

- **Oscilloscope-Controlled Time and Frequency Measurements**
- **10-ns Single-Shot Time-Interval Measurement Resolution**
- **Time-Interval Averaging**
- **CRT Display of Counting Interval**
- **10-ps Period-Averaging Resolution**
- **Frequency Measurements Directly to 225 MHz**
- **Signal Conditioning via Mainframe Trigger Source**

For Measurement Applications Guide order 42-W-5017-1.

The 7D15 Universal Counter/Timer is designed for use in all 7000-Series oscilloscope mainframes having CRT readout. The 7D15 can be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, measurements can be made between any two points on the CRT display (see Figure 1).

The 7D15 offers all the measurement capabilities of a Universal Counter/Timer, such as time interval, period, period and time interval averaging, frequency, frequency ratio, totalize, and manual stop watch.

The 7D15 may be used in vertical or horizontal compartments of 7000-Series mainframes. It provides a full eight-digit CRT display with leading-zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

Modes	Range	Accuracy
Frequency Mode	DC to 225 MHz, Resolution is 0.1 Hz max.	$\epsilon_{Freq\ (Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T}$
Period and Multi-Period Mode	10 ns to 10^5 seconds with selected averaging of 1 to 1000 events in decade steps. Resolution to 10 ps.	$\epsilon_{Period\ (s)} = \pm TB \cdot P_{in} \pm \frac{10^{-9}}{N} \pm \frac{2E_{npk}}{\frac{dv}{dt} \cdot N} \pm \frac{P_{ck}}{N}$
Time Interval (TI) and TI Average Mode	6 ns to 10 seconds with selected averaging of 1 to 1000 in decade steps. Resolution is 0.1 ns.	$\epsilon_{TI\ (s)} = \pm TB \cdot P_{in} \pm \frac{P_{ck}}{\sqrt{N}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	10^{-7} to 10^4	
Manual Stop Watch	0 to 10^5 seconds	
Totalize, CH B	0 to 10^8 counts	

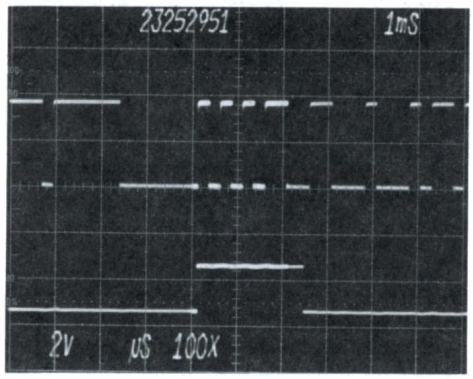


Figure 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time-interval measurement from third to seventh pulse on CRT display. Counter CH A is "armed" with leading edge of B gate while CH B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 µs.

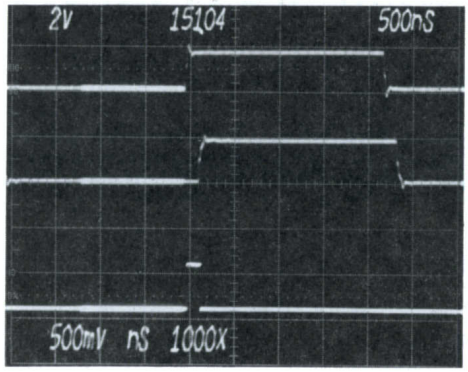


Figure 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.

CHARACTERISTICS

INPUT SIGNAL CH A & B

Frequency Range (CH B Only)—DC Coupled: DC to 225 MHz. AC Coupled: 5 Hz to 225 MHz.

Sensitivity (CH A and B Inputs)—100 mV p-p. Trigger Source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical-system bandwidth, whichever is less.

Input R and C—1 MΩ and 22 pF.

Triggering (Preset Position)—Automatically triggers at 0 V.

Level-Control Range (CH A and B Inputs)—100 mV Range: ±500 mV. 1 V Range: ±5 V. 10 V Range: ±50 V.

Arming Inputs—Input R and C: 10 kΩ and 20 pF. Sensitivity Arm A: Logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity Arm B: Logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

External Clock-In—20 Hz to 5 MHz.

Reset Front Panel—Readies the instrument. All counters are affected, including averaging circuits.

INTERNAL TIME BASE

Crystal Oscillator—Accuracy: Within 0.5 ppm (0 to +50°C ambient). Long-Term Drift: 1 part or less in 10^7 per month. Oscillator: Temperature compensated; no warm-up is required.

OUTPUT SIGNALS

Clock Out—Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤ 0 V into 50 Ω. TTL compatible without 50-Ω load (1.6 mA current capacity).

A and B Trigger Level—$Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (Internally Connected)— Front-panel switch screwdriver controlled selects true gate, pseudo gate, or CH B signal out.

External Display—Same as internal except position control has no effect.

Display-Mode Switch—0.1 s to 5 s; also a preset position for infinite display time. Allows selection of readout "follow or store."

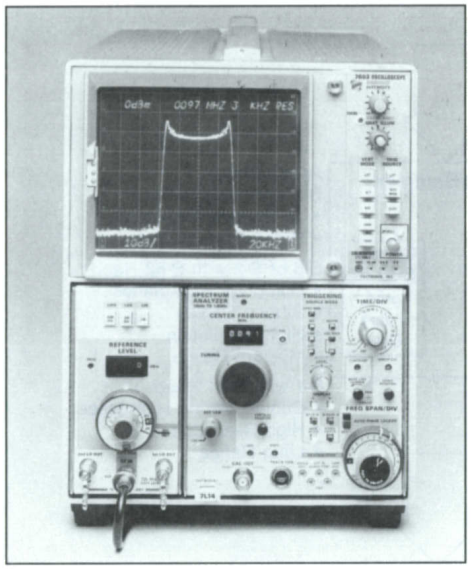
Readout—Eight-digit display; the four most significant have zero suppression. Overflow indicated by a greater than symbol.

ORDERING INFORMATION

7D15 Universal Counter/Timer **$3,960**

Includes: Two 44-inch Sealectro-to-BNC connector cables (012-0403-00); instruction manual (070-1433-00).

For recommended probes, see 7000-Series Reference section and Accessories section.



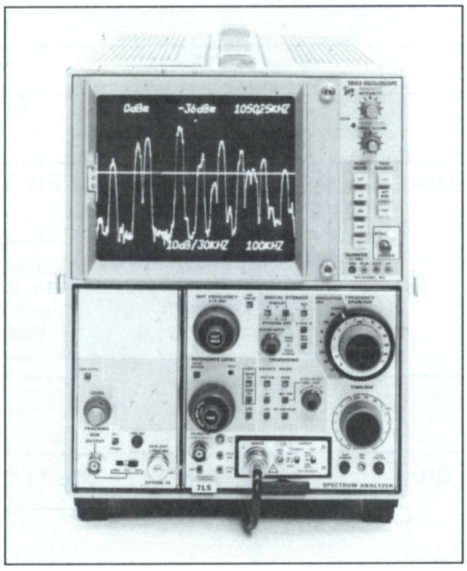
7L14

- **Excellent Stability, Resolution Bandwidth Range**
- **Digital Storage and Averaging**
- **Swept Measurements With the Tek TR 502**
- **1-kHz to 2.5-GHz Coverage (Option 39)**
- **Input Limiter for Extra Input Protection**
- **Semiautomatic Measurements With the Tek 7854**

The Tektronix 7L14 is a VHF/UHF analyzer with digital storage. It provides high performance in the 10-kHz to 1.8-GHz range. Measurements for RFI/EMC, FM, TV, avionics, navigation, two-way, and other communications systems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability—incidental FM is ≤13 Hz peak-to-peak. Phase noise sidebands are no greater than −70 dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more. . .easily and economically.



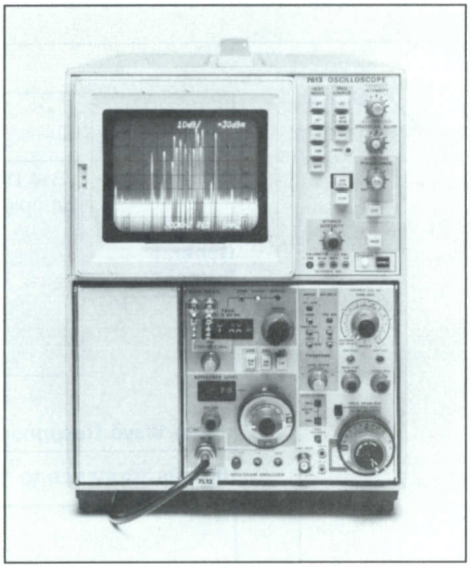
7L5

- **Synthesizer Tuning**
- **Digital Storage and Averaging**
- **Three-Knob Operation**
- **Preset Reference Level and Dot Frequency for Extra Input Protection**
- **Swept Measurements (Option 25)**
- **Selectable Input Impedance; Calibration in dBm, dBV, or Volts per Division**
- **Semiautomatic Measurements With the Tek 7854**

The Tektronix 7L5 provides easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω, or 1 MΩ. The L3 Option 01 is switch-selectable to 75 Ω, 600 Ω, or 1 MΩ.

For a complete description of the 7L14, 7L12, or 7L5, see the Spectrum Analyzers section.



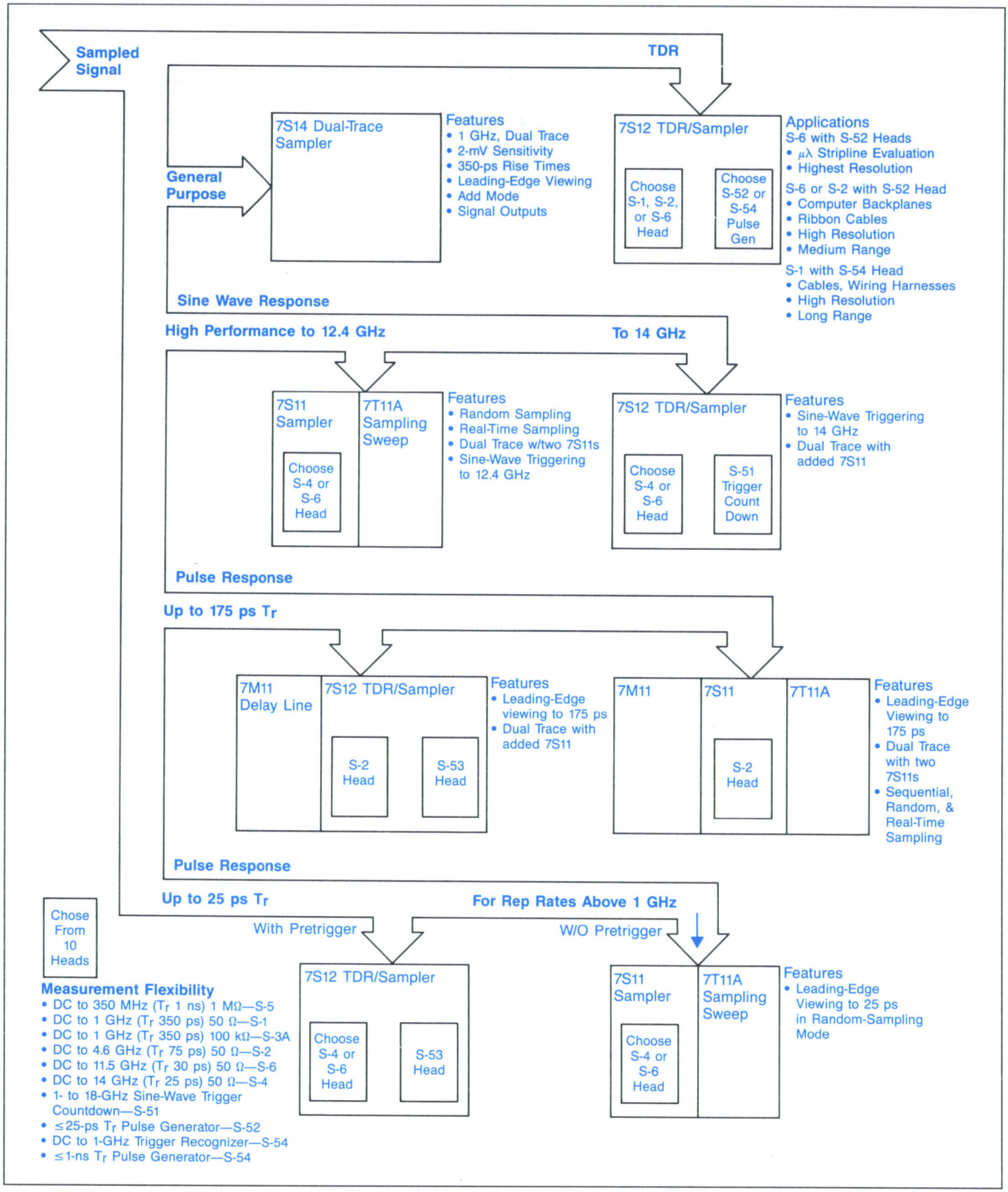
7L12

- **Proven, Economical VHF/UHF Coverage**
- **Automatic Phaselock, 300-Hz Resolution Bandwidth**
- **Swept Measurements With the TR 502**
- **1-kHz to 2.5-GHz Coverage (Option 39)**
- **Semiautomatic Measurements With the Tek 7854**

The 7L12 is a popular instrument in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with −115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is ≤200 Hz peak-to-peak.

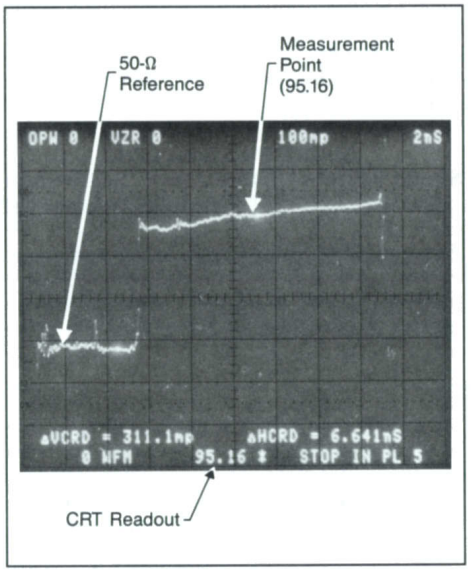
The 7L12 meets the measurement requirements of many AM, FM, two-way radio, and other communications systems.

The 7L12 has a 70-dB spurious-free display dynamic range; low-level noise measurements are made accurately, easily.

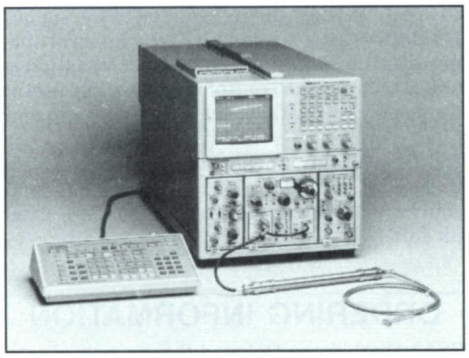

Sampled Signal
TDR
General Purpose
7S14 Dual-Trace Sampler
Features
• 1 GHz, Dual Trace
• 2-mV Sensitivity
• 350-ps Rise Times
• Leading-Edge Viewing
• Add Mode
• Signal Outputs
7S12 TDR/Sampler
Choose S-1, S-2, or S-6 Head
Choose S-52 or S-54 Pulse Gen
Applications
S-6 with S-52 Heads
• μλ Stripline Evaluation
• Highest Resolution
S-6 or S-2 with S-52 Head
• Computer Backplanes
• Ribbon Cables
• High Resolution
• Medium Range
S-1 with S-54 Head
• Cables, Wiring Harnesses
• High Resolution
• Long Range
Sine Wave Response
High Performance to 12.4 GHz
To 14 GHz
7S11 Sampler
Choose S-4 or S-6 Head
7T11A Sampling Sweep
Features
• Random Sampling
• Real-Time Sampling
• Dual Trace w/two 7S11s
• Sine-Wave Triggering to 12.4 GHz
7S12 TDR/Sampler
Choose S-4 or S-6 Head
S-51 Trigger Count Down
Features
• Sine-Wave Triggering to 14 GHz
• Dual Trace with added 7S11
Pulse Response
Up to 175 ps Tr
7M11 Delay Line
7S12 TDR/Sampler
S-2 Head
S-53 Head
Features
• Leading-Edge viewing to 175 ps
• Dual Trace with added 7S11
7M11
7S11
S-2 Head
7T11A
Features
• Leading-Edge Viewing to 175 ps
• Dual Trace with two 7S11s
• Sequential, Random, & Real-Time Sampling
Pulse Response
Up to 25 ps Tr
For Rep Rates Above 1 GHz
With Pretrigger
W/O Pretrigger
Chose From 10 Heads
7S12 TDR/Sampler
Choose S-4 or S-6 Head
S-53 Head
7S11 Sampler
Choose S-4 or S-6 Head
7T11A Sampling Sweep
Features
• Leading-Edge Viewing to 25 ps in Random-Sampling Mode
Measurement Flexibility
• DC to 350 MHz (Tr 1 ns) 1 MΩ—S-5
• DC to 1 GHz (Tr 350 ps) 50 Ω—S-1
• DC to 1 GHz (Tr 350 ps) 100 kΩ—S-3A
• DC to 4.6 GHz (Tr 75 ps) 50 Ω—S-2
• DC to 11.5 GHz (Tr 30 ps) 50 Ω—S-6
• DC to 14 GHz (Tr 25 ps) 50 Ω—S-4
• 1- to 18-GHz Sine-Wave Trigger Countdown—S-51
• ≤25-ps Tr Pulse Generator—S-52
• DC to 1-GHz Trigger Recognizer—S-54
• ≤1-ns Tr Pulse Generator—S-54

Sampling Plug-ins

7000-Series sampling plug-ins can increase the versatility of your mainframe by providing measurement capabilities up to 14 GHz on repetitive signals. The sampling family consists of five plug-ins, ten specially-designed sampling heads, and various supporting accessories that provide maximum configurability for numerous applications.



CRT photo shows an automated impedance measurement on a four-foot length of 93-Ω coax. An easy-to use program allows the operator to obtain a direct readout in ohms (bottom center) after positioning cursors on selected points on the display.



The 7854/7S12 combination is ideally suited for making a wide variety of automated sampling measurements. Examples of easy-to-program measurements are: measuring propagation delay through active or passive devices; measuring distance to faults in coax cables; and measuring impedance in EC boards and other controlled-impedance devices. Programs can be entered into the 7854 via the calculator keyboard for simple operator-controlled measurements, or tests can be computer-controlled via a remote terminal on the GPIB for production applications.

Specific uses for samplers include general UHF measurement and TDR (Time-Domain Reflectometry.)

UHF Measurements

For flexibility in time-domain measurements, the 7S11 Sampling Unit/7T11A Sampling Sweep combination provides triggering to 12.4 GHz and the choice of modular heads for optimum signal acquisition. Two 7S11s and one 7T11A provide dual-trace capability. For plug-in sampler operationally similar to conventional vertical/time-base plug-ins, the 1-GHz 7S14 is available. Two identical channels provide 2-mV/div sensitivity, dual-trace display, built-in time base, and calibrated delayed sweep. All of these plug-ins provide a cost-effective way to obtain gigahertz measurement capability for repetitive signals.

TDR

TDR is widely used in microwave stripline evaluation, computer backplane measurements, and printed circuit board testing. With TDR, a pulse is sent down a conductive path and measured as it reflects back from any impedance changes in the device under test. Any impedance variations in the path cause a corresponding signal to be displayed on the scope. The precise location and type of impedance anomaly (open, short, step change) in the conductive path is directly readable on the display. The fast rise times of samplers make them well-suited for these measurements. The high-resolution 7S12 TDR Sampler provides maximum versatility in addition to general-purpose applications.

See the Sampling Decision Tree on the preceding page for system configurations.

SAMPLING-HEAD CHARACTERISTICS

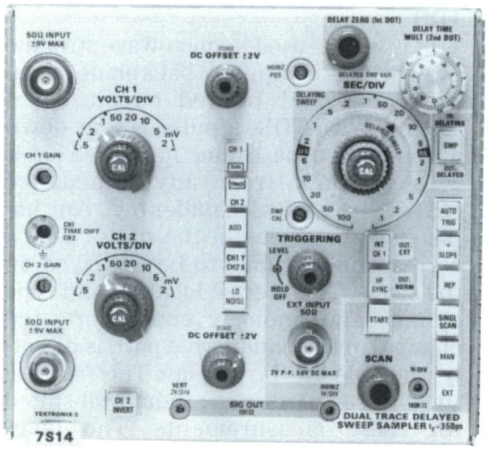
	Bandwidth	Rise Time	Input Impedance	Noise	Connector
S-1	DC to 1 GHz	≤ 350 ps	50 Ω	≤1 mV*1 ≤2 mV*2	GR
S-2	DC to 4.6 GHz	≤75 ps	50 Ω	≤3 mV*1 ≤6 mV*2	GR
S-3A	DC to 1 GHz	≤350 ps	— 100 kΩ	≤3 mV at probe tip*2	Probe
S-4	DC to 14 GHz	≤25 ps	50 Ω	≤2.5 mV*1 ≤5 mV*2	SMA (3 mm)
S-5	DC to 350 MHz	≤1 ns	1 MΩ	≤500 μV*1 ≤5 mV*2	BNC
S-6	DC to 11.5 GHz	≤30 ps	50 Ω feed thru	— ≤5 mV*2	SMA (3 mm)

*1 *Smoothed*
*2 *Unsmoothed*

ACCESSORY PROBES FOR 50-Ω SAMPLERS

Type	Attenuation	Length*1	Loading		Rise Time (ns)	Bandwidth	Package Number*2
Passive							
P6056	10X	6.0	500 Ω	1 pF	<0.1	DC to 3.5 GHz	P6056
P6057	100X	6.0	5 kΩ	1 pF	<0.25	DC to 1.4 GHz	P6057
Active—FET*3							
P6201	1X 10X 100X	6.0 6.0 6.0	100 kΩ 1 MΩ 1 MΩ	3 pF 1.5 pF 1.5 pF	<0.4 <0.4 <0.4	DC to 900 MHz DC to 900 MHz DC to 900 MHz	P6201 (includes attenuators)
P6202A	10X 100X	2 m 2 m	10 MΩ 10 MΩ	2 pF 2 pF	<0.7 <0.7	DC to 500 MHz DC to 500 MHz	P6202A plus 010-0384-00 to provide 100X
Active—Variable Bias/Offset*3							
P6230	10X	1.6	450 Ω	1.6 pF	≤0.23 ps	DC to 1.5 GHz	P6230

*1 *Length in feet except where specified.*
*2 *Refer to probe section for additional information.*
*3 *Requires power source: Most four-compartment mainframes provide probe power. See Accessories section for Probe Power Supplies.*



7S14 Dual-Trace, Delayed-Sweep Sampler

7S14

- **Calibrated Delayed Sweep**
- **Two-Dot Time Measurement**
- **DC to 1-GHz Bandwidth**
- **Dual Trace, 2-mV Sensitivity**
- **CRT Readout**
- **Simplified Triggering**
- **Operational Ease of a Conventional Oscilloscope**

The 7S14 Sampling Unit provides dual-trace 1-GHz bandwidth in the 7000-Series oscilloscope mainframes. The 7S14 occupies two plug-in compartments of a mainframe.

The two identical vertical channels of the 7S14 provide 2-mV per division sensitivity at the full 1-GHz bandwidth of the instrument. The 7S14 also uses a two-ramp time base that provides calibrated delayed sweep to 100 ps per division.

Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional 7000-Series oscilloscopes. Front-panel controls are grouped and color-coded by function, and control nomenclature is similar to that of conventional oscilloscopes.

The two-dot measurement capability of the 7S14 provides an easy and accurate means of measuring time intervals on the displayed waveform. The two dots are positioned by the Delay controls; the time interval between them is determined by multiplying the Delay Time Multiplier setting by the selected time per division. This eliminates the need to interpolate between graticule markings on the CRT.

CHARACTERISTICS

VERTICAL CHANNEL

Modes—CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 Invert); CH 1 Vertical (Y), CH 2 Horizontal (X).

Input Impedance—Nominally 50 Ω.
Bandwidth—Equivalent to dc to 1 GHz.
Rise Time—350 ps or less.
Step Aberrations—+2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, both tested with a 284 Pulse Generator.
Deflection Factor—2 mV to 0.5 V/div in eight steps (1-2-5 sequence). Continuously variable between steps to at least 2.5 to 1.
Accuracy—±3%.
Maximum Input Voltage—±5 V.
Input-Signal Range—2 V p-p maximum within a +2- to −2-V window at any sensitivity.
DC Offset Range—At least +2 to −2 V.
Displayed Noise—2 mV or less unsmoothed (measured tangentially). Low-noise pushbutton reduces random noise by a factor of 4 to 1 or more.
Vertical Signal Output—0.2 V/div of vertical deflection; 10-kΩ source resistance.
Channel Delay Difference—Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE

Scan Modes—Repetitive, single, manual, or external.
Delaying Sweep—May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying-sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the Time/div.
Delayed Sweep—This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.
Horizontal Signal Output—1.0 V/div of horizontal deflection; 10-kΩ source resistance.

DELAYING SWEEP

Range— 10 ns to 100 μs/div in 13 steps (1-2-5 sequence).
Accuracy—±3%, excluding first 0.5 division of displayed sweep.
Delayed Zero (1st Dot)—Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the delaying sweep selected.
Delay Time (2nd Dot)—Adjustable to any position of the time interval represented by ten divisions of the delaying sweep selected.
Delay Accuracy—Within 1% of ten divisions when measurement is made within the last 9.5 division.

DELAYED SWEEP

Range—100 ps to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps to at least 2.5 to 1.
Accuracy—Within 3% excluding first 0.5 divisions of displayed sweep.
Start Delay—Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by ten divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.
Delay Jitter—<0.05% of the time represented by one division of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources—Internal from CH 1 vertical input or external through front-panel connector.
External Triggering—Nominal 50-Ω input, ac coupled, 2 V p-p 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less, 10 Hz to 100 MHz. Sine wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.
Internal Triggering—Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine wave amplitude 50 mV p-p or more from 150 Hz to 100 MHz.
Triggered Mode—Trigger recognition may be made to occur at any selected voltage level between +0.5 and −0.5 V on either a + slope or a − slope of the triggering signal.
Autotrigger Mode—For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger-level range automatically adjusts to approximately the p-p voltage of the signal.
Holdoff—Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.
HF Sync Mode—For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

ORDERING INFORMATION

7S14 Dual Trace Delayed Sweep Sampler for 7000-Series Oscilloscopes **$6,490**
Includes: Two X10 attenuators (011-0059-02); two 42-in. 50-Ω coaxial cables (012-0057-01); instruction manual (070-1410-00).

TRAINING

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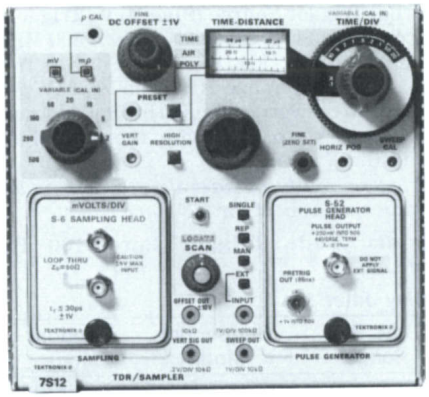


7S12 TDR/Sampler

7S12

- **45-ps TDR or General-Purpose Sampler**
- **6 Plug-In Sampling Heads Available**
- **2 Plug-In Pulse Sources Available**
- **1 Trigger-Recognizer Head Available**
- **1 Trigger-Countdown Head Available**

The 7S12 is a combined vertical-horizontal, double-width plug-in for high-resolution TDR or general-purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse-Generator Head, the 7S12 has a system rise time of 45 ps (return from short-circuit termination) and distance range to 250 feet in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 to 500 mρ/div and in voltage from 2 to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long-line TDR using the S-5 Sampling Head and S-54 Pulse-Generator Head, distance calibration extends to 4900 feet (air line) and discontinuities to twice this distance may be viewed. System rise time with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger-Recognizer Head or S-51 Trigger-Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

CHARACTERISTICS

SYSTEM PERFORMANCE WITH S-6 AND S-52

System Rise Time—35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1-ns test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated one-way distance to at least 375 ft (air line). Time range is at least 0.75 μs round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude—At least +200 mV into 50 Ω.

Input Characteristics—Nominal 50 Ω, feed-through signal channel (termination supplied). SMA (3 mm) connectors.

Jitter—<10 ps (without signal averaging).

Aberrations—+7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, -2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

System Rise Time—1.5 ns or less for the displayed reflection from a short-circuited test line.

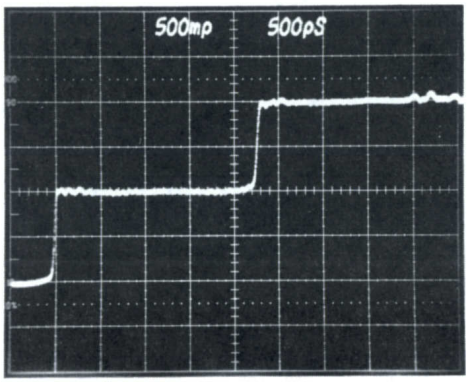
Time and Distance Ranges—Direct-reading tape dial gives calibrated one-way distances to 4900 ft (air line), 3240 ft solid polyethylene. Time range is 20 μs round trip.

Pulse Amplitude—At least +400 mV into 50 Ω.

Input Characteristics—Nominal 50-Ω test line connection (cable and T supplied). BNC connectors.

Jitter—<20 ps (without signal averaging).

Aberrations—+4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.



The 7S12 displays reflection coefficient (ρ) versus distance on a device-under-test. Here the 7S12 measures a reflection caused by a crack (open) in a PCB under test. Distance can be read directly from the 7S12 front panel or calculated from the time-base settings.

OTHER 7S12 CHARACTERISTICS

Vertical Scale—Calibrated in mρ (reflection coefficient$\times 10^{-3}$) and mV from 2 to 500 units/division in eight steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

Resolution—Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

DC Offset Range—+1 to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

Time/Distance—Tape Dial is Calibrated in Time and Distance: Full scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

Time/Div—20 ps to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button—Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes—Repetitive or single sweep, manual or external scan.

Signal Outputs—Pin jacks provide both vertical signal and sweep outputs.

ORDERING INFORMATION

7S12 TDR/Sampler Without Sampling Heads (Tape Dial in Feet) **$3,715**

Includes: 750-ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR graticule overlay (331-0296-00); TDR slide rule (003-0700-00); TDR graticule overlay (331-0297-00); instruction manual (070-1244-00).

Option 03—Tape Dial Change (Meters). **+$25**

RECOMMENDED MAINFRAMES

7603 Oscilloscope Mainframe **$4,235**

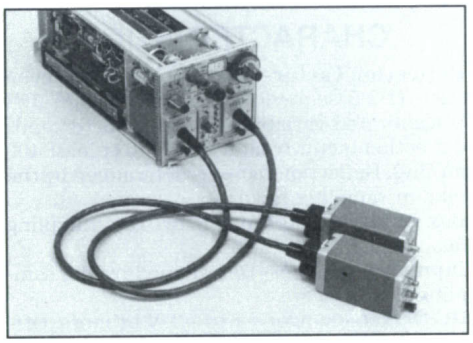
7854 Waveform Processing Oscilloscope **$15,275**

OPTIONAL ACCESSORIES

Sampling-Head Extender—

(3 ft) Order 012-0124-00 **$470**

(6 ft) Order 012-0125-00 **$535**



Extenders allow the user to locate the sampling head directly in a test fixture, avoiding potential signal degradation by cables.

TRAINING

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For sampling heads, see later in this section. See 1502 and 1503 Portable TDR Cable Testers in the Communications Products section.

7S11 Sampling Unit

7T11A Sampling Sweep Unit

7S11

- **2- to 200-mV/Div Calibrated Deflection Factors**
- **Plug-In Sampling Heads**

The 7S11 single-channel sampling unit employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz. The 7S11 is used for a variety of applications. Single-channel sampling uses one 7S11 with a 7T11A. Two 7S11s and one 7T11A provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

CHARACTERISTICS

Deflection Factor—2 to 200 mV/div in seven steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous (extends deflection factor from 2 mV/div to at least 400 mV/div). Deflection factor is determined by the plug-in sampling head.
Bandwidth—Determined by the sampling head.
Input Impedance—Determined by the sampling head.
DC Offset—Range, +1 to −1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.
Delay Range—At least 10 ns for comparing two signals in a dual-trace application.
Memory Slash—0.1 div or less at 20 Hz.
Vertical Signal Out—200 mV per displayed div within 3%.
Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0 to +50°C.

ORDERING INFORMATION

7S11 Sampling Unit Without Sampling Head **$1,995**
Includes: —Instruction manual (070-0985-00).

7T11A

- **10-ps to 5-ms/Div Calibrated Time Base**
- **Random or Sequential Sampling**
- **Equivalent- or Real-Time Sampling**
- **No Pretrigger Required**

The 7T11A Sampling Time Base provides equivalent- and real-time horizontal deflection for single- or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is below 1%. Triggering range is from approximately 10 Hz (sequential mode) to above 12.4 GHz. The 7T11A works with all 7000-Series instruments and is a companion unit to the 7S11.

CHARACTERISTICS

Time/Division Range—10 ps to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated variable is continuous between steps to at least 4 ps/div.
Time Position Range—Equivalent time is 50 ns to 50 μs in four steps; real time is 0.05 ms to 50 ms in three steps.
Time/Division Accuracy—Within 3% for all time/division settings over center 8 cm.

TRIGGERING

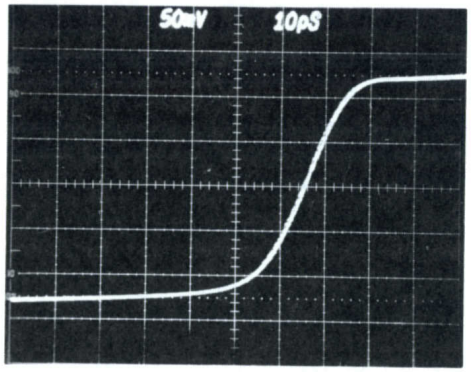
External 50-Ω Input—Frequency range: dc to 1 GHz in X1 Trig Amp mode. Sensitivity range: 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R: 50 Ω within 10%. Max input voltage: 2 V (dc + peak ac).
External 1-MΩ Input—Frequency range is dc to 100 MHz in X1 Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 1 MΩ within 5%. Maximum input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a minimum 5 V p-p).
External HF Sync—Frequency range: 1 to 12.4 GHz. Sensitivity range: 10 to 500 mV p-p. Input R: 1 MΩ. Max input voltage: 2 V p-p.
Internal Trigger Source (Sine Wave Triggering)*1—Frequency range is 5 kHz to 500 MHz in X1 Trig Amp: 5 kHz to 50 MHz in X10 Trig Amp. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 Trig Amp; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 Trig Amp.
*1 *Trigger circuits will operate to dc with pulse triggering, except for HF Sync.*
Random Mode Trigger Rate—100 Hz minimum.

Display Jitter*1

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

*1 *Measured under optimum trigger conditions with Time/Division switch clockwise.*

Pulse Out—Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5-ns rise time or less.
Trigger Kickout—2 mV or less into 50 Ω (except HF Sync).
Display Scan Rate—Continuously selectable from at least 40 sweeps/s to <2 sweeps/s.
External Scan—Deflection factor is continuously variable from 1 to 10 V/div. Input R is 100 kΩ within 10%. Maximum input voltage is 100 V (dc + peak ac).
Sweep Out—1 V/div within 2%. Source R is 10 kΩ within 1%.
Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0 to +50°C.



7S11/7T11A provide accurate measurements on repetitive signals. Pulse rise time of 21 ps shown.

ORDERING INFORMATION

7T11A Sampling Sweep Unit **$4,880**
Includes: 42-inch BNC 50-Ω cable (012-0057-01); 3-mm SMA male to BNC adaptor (015-1018-00); 3-mm SMA male to GR874 adaptor (015-1007-00); 10X 50-Ω attenuator (011-0059-02); instruction manual (070-0986-00).

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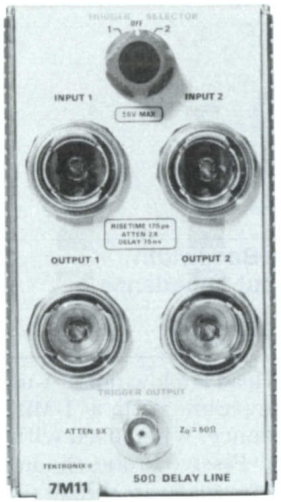


7M11 Delay Line

7M11

- **75-ns Time Delay**
- **Selectable Trigger Out**
- **175-ps Rise Time**

The 7M11 is a passive dual delay line for use with the 7000-Series sampling system. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per division settings.

Vertical delay for two 7S11 vertical sampling units is available with the 50-Ω, 75-ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175-ps rise time, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a rise time of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay—75 ns within 1 ns.
Delay Difference—30 ps or less between channels.
Rise Time—175 ps or less.
Attenuation—2X within 2% into 50 Ω.
Input Impedance—50 Ω within 2%.
Maximum Input—±5 V (dc + peak ac).

TRIGGER OUTPUT

Rise Time—600 ps or less.
Attenuation—5X within 10% into 50 Ω (referred to input).
Output Impedance—50 Ω within 10%.
Ambient Temperature—Performance characteristics are valid over a range of 0 to +50 °C.

ORDERING INFORMATION

7M11 Delay Line **$1,730**
Includes: Two 2-ns GR cables (017-0505-00); ten-inch BNC cables (012-0208-00); instruction manual (070-0987-00).

S-1

- **DC to 1-GHz Bandwidth**
- **Clean Transient Response**
- **Internal Trigger Pickoff**

The S-1 Sampling Head is a low-noise, 350-ps rise time unit with a 50-Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger-signal output from the plug-in unit.

Rise Time—350 ps or less.
Bandwidth—Equivalent to dc to 1 GHz at 3 dB down.
Transient Response—Aberrations as observed with the 284 Pulse Generator are +0.5%, −3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; −0.5% or less, total of 1% or less p-p after 5 ns.
Displayed Noise—Smoothed: 1 mV. Unsmoothed: 2 mV or less.
Signal Range—Variable dc offset allows signals between +1 and −1 V limits to be displayed at 2 mV/div. Signals between +2 and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <500 mV p-p.
Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.
Weights—Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

ORDERING INFORMATION

S-1 Sampling Head **$1,505**
Includes: 5-ns, 50-Ω RG58 A/U cable (017-0512-00); 10X, 50-Ω GR attenuator (017-0078-00); instruction manual (070-0763-00).

S-2

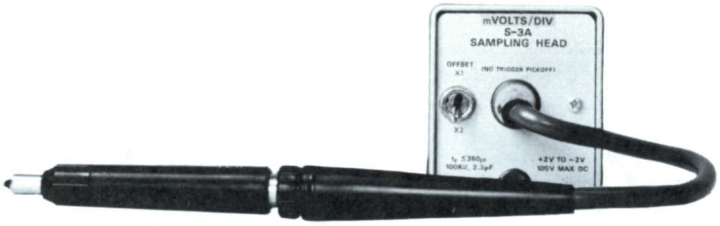
- **DC to 4.6-GHz Bandwidth**
- **Displayed Noise <6 mV (Unsmoothed)**
- **Internal Trigger Pickoff**

The S-2 Sampling Head is a 75-ps rise time unit with a 50-Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger-signal output from the plug-in unit.

Rise Time—75 ps or less.
Bandwidth—Equivalent to dc to 4.6 GHz at 3 dB down.
Transient Response—Aberrations as observed with the 284 Pulse Generator are +5%, −5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, −2% or less total of 4% or less p-p after 2.5 ns.
Displayed Noise—Smoothed: 3 mV. Unsmoothed: 6 mV or less.
Signal Range—Variable dc offset allows signals between +1 and −1 V limits to be displayed at 2 mV/div. Signals between +2 and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <200 mV p-p.
Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.
Weights—Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

ORDERING INFORMATION

S-2 Sampling Head **$1,695**
Includes: 10X 50-Ω GR attenuator (017-0078-00); 5-ns, 50-Ω RG213/U Cable (017-0502-00); instruction manual (070-0764-00).



S-3A

- **Displayed Noise <3 mV (Unsmoothed)**
- **DC to 1-GHz Bandwidth**
- **Compact, 4.5-ft, 100-kΩ, 2.3-pF Probe**

The S-3A Sampling Head is an active sampling-probe unit with 100-kΩ, 2.3-pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2-mV/div deflection factor.

Rise Time—350 ps or less.

Bandwidth (Probe only)—Equivalent to dc to 1 GHz at 3 dB down.

Transient Response (Probe only)—Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

Displayed Noise (Probe only)—3 mV or less referred to probe tip (includes 90% of dots).

Signal Range—Variable dc offset allows signals between +1 and −1 V, 1X range, or +2 and −2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.

Weight—Net: 1.4 kg (3.0 lb). Shipping: 2.3 kg (5.0 lb).

ORDERING INFORMATION

S-3A Sampling Head **$2,280**

Includes: 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); two test-point jacks (131-0258-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip ground adaptor (013-0085-00); 5½-inch ground lead (175-1017-00); 12½-inch ground lead (175-1018-00); 3-inch cable assembly (195-6176-00); end cap (200-0834-00); three ground clips (344-0046-00); two end caps (200-0835 00); probe holder (352-0090-00); carrying case (016-0121-01); 6-inch elec lead (175-0849-00); 3-inch elec lead (175-0849-00); retractable hook tip (013-0097-01); 50-Ω voltage pickoff (017-0077-01); instruction manual (070-1148-00).

S-4

- **Displayed Noise <5 mV (Unsmoothed)**
- **25-ps Rise Time**
- **Internal Trigger Pickoff**

The S-4 Sampling Head is a 25-ps rise time unit with a 50-Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

Rise Time—25 ps or less.

Bandwidth—Equivalent to dc to 14 GHz at 3 dB down.

Transient Response—Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, −0%, +10% or less, total of 10% or less, p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.

Displayed Noise—Smoothed: 2.5 mV. Unsmoothed: 5 mV or less.

Signal Range—Variable dc offset allows signals between +1 and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. SMA (3 mm) input connector.

Weight—Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

ORDERING INFORMATION

S-4 Sampling Head **$2,500**

Includes: 10X, 50-Ω SMA attenuator (015-1003-00); 2-ns cable with SMA connectors (015-1005-00); GR874 to SMA male adaptor (015-1007-00); SMA male-to-male adaptor (015-1011-00); $^{5}/_{16}$ inch wrench (003-0247-00); instruction manual (070-0896-01).

S-5

- **DC to 350-MHz Bandwidth**
- **1-MΩ, 15-pF Input Impedance**
- **Passive Probe**
- **Internal Trigger Pickoff**

The S-5 Sampling Head is a low-noise, 1-ns rise time sampling unit with a 1-MΩ, 15-pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1-ns rise time at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Rise Time—S-5 Only: 1 ns or less. With 3.5 ft P6010: 1 ns or less.

Bandwidth—Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.

Transient Response—S-5 Only (Driven with a 50-Ω Source Terminated in 50 Ω): Aberrations +2.5%, −5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, −1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft Probe, Properly Compensated): Aberrations +5%, −5% or less total of 10% or less p-p within 25 ns after step; +1%, −1% or less total of 2% or less p-p thereafter.

Displayed Noise—S-5 Only: 500 μV or less (includes 90% of dots). S5/P6010: 5 mV or less (includes 90% of dots).

Signal Range—S-5 Only: DC coupled is 1 V p-p from +1 to −1 V. AC coupled is 1 V p-p. S5/P6010: DC coupled (dc + peak ac) is 10 V p-p. AC coupling, dc voltage is 100 V.

Input Characteristics—S-5 Only: 1 MΩ within 1% paralleled by 15 pF. S-5/P6010: 10 MΩ paralleled by ≈10 pF.

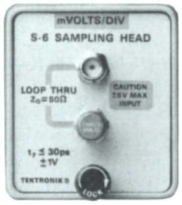
Attenuator Accuracy—Probe attenuation is 10X within 3%.

Weight—Net: 0.3 kg (0.6 lb). Shipping: 0.9 kg (2.0 lb).

ORDERING INFORMATION

S-5 Sampling Head **$1,720**

Includes: 50-Ω termination (011-0049-01); P6010 probe package (010-0188-00); instruction manual (070-0942-00).



S-6

- **30-ps Rise Time**
- **Displayed Noise <5 mV (Unsmoothed)**
- **Loop-Through Input**

The S-6 Sampling Head is a 50-Ω feed-through unit for high-speed applications.

Rise Time—30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

Bandwidth—Equivalent to dc to 11.5 GHz at 3 dB down.

Transient Response—Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Displayed Noise—5 mV or less, measured tangentially.

Signal Range—+1 to −1 V (dc + peak ac). 1 V p-p. DC offset allows any portion of input signal to be displayed.

Input Characteristics—Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Safe overload is ±5 V.

Weight—Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

ORDERING INFORMATION

S-6 Sampling Head **$1,900**

Includes: 50-Ω termination (015-1022-00); 1-ns 50-Ω cable (015-1019-00); SMA (3 mm) female-to-female adaptor (015-1012-00); combination wrench (003-0247-00); SMA male-to-GR874 adaptor (015-1007-00); instruction manual (070-1128-01).

TIMING AND PULSE-GENERATOR HEAD CHARACTERISTICS

	Bandwidth	Rise Time	Application
S-51	1 GHz to 18 GHz trigger countdown	—	High-Speed Sine-Wave Sampling
S-52	—	≤25 ps	High-Resolution TDR
S-53	DC to 1 GHz trigger recognizer	—	General-Purpose Sampling
S-54	—	≤1 ns	Medium-Resolution TDR

S-51

- **18-GHz Countdown**
- **10 ps or Less Trigger Jitter**

The S-51 Trigger-Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of sine waves from 1 to 18 GHz. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger-output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

Input Signal—Frequency range is 1 to 18 GHz. Stable synchronization on signals of at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p maximum.

Input Characteristics—50-Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

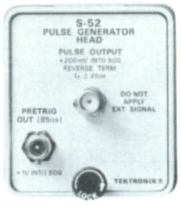
Trigger Output—Front-panel trigger output is at least 200 mV into 50 Ω, BSM-type connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 to 18 GHz; 15 ps or less with signals from 1 to 5 GHz. Kickout at signal-input connector is 400 mV or less; kickout occurs between successive samples.

Weight—Net: 0.5 kg (1.0 lb). Shipping: 2.3 kg (5.0 lb).

ORDERING INFORMATION

S-51 Trigger-Countdown Head **$1,825**

Includes: Instruction manual (070-0898-00).



S-52

- **25-ps Rise Time**
- **200 mV Into 50 Ω**
- **50-Ω Source**
- **Pretrigger Output**

The S-52 Pulse-Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high-resolution TDR (Time-Domain Reflectometer). For TDR applications, it features automatic bias-circuit control to eliminate effects of tunnel-diode and load changes. A 50-Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 250 ft in any cable. A pretrigger output allows operation in sequential-sampling systems without a delay line.

Pulse Output—Rise time is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive going. Pulse duration when used with the 7S12 in the TDR mode is typically 750 ns. Pulse duration when powered by the 7S11 is >800 ns. Pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Pretrigger Output—Rise time is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

Output Connectors—Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

Weight—Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

ORDERING INFORMATION

S-52 Pulse-Generator Head **$1,500**

Includes: 1-ns, 50-Ω semirigid coax delay line (015-1023-00); instruction manual (070-1101-01).

S-53

- **DC to 1-GHz Operation**
- **10-mV Sensitivity**

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

Input Characteristics—Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

Output Characteristics—Rise time is 1 ns or less. Amplitude is at least 1.5 V positive going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less.

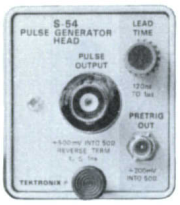
Connectors—Trigger-input connector is BNC type. Front-panel trigger-output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

Weight—Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

ORDERING INFORMATION

S-53 Trigger-Recognizer Head **$1,530**

Includes: 42-inch, 50-Ω cable (012-0057-01); 10X 50-Ω attenuator (011-0059-02); instruction manual (070-1147-00).



S-54

- **1-ns Rise Time**
- **Low Aberrations**
- **400 mV Into 50 Ω**
- **Variable Pretrigger Lead Time**

The S-54 Pulse-Generator Head is a step generator designed for use with the 7S12 as a long-line TDR unit.

For TDR applications, the S-54 is 50-Ω reverse terminated to minimize reflections and has a 0-V base line to eliminate base-line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows operation in sequential-sampling systems without a delay line.

Pulse Output—Rise time is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base-line level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output—Rise time is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive going. Pretrigger-pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front-panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to pulse-output jitter is 100 ps or less at 120-ns lead time to 1 ns or less at 1-μs lead time.

Output Connectors—Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Weight—Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

ORDERING INFORMATION

S-54 Pulse Generator Head **$1,470**

Includes: BNC T connector (103-0030-00); 8-inch 50-Ω cable (012-0118-00); instruction manual (070-1093-00).

OPTIONAL SAMPLING ACCESSORIES

CT-1 Current Transformer—With GR Cable. **$230**

Coupling Capacitor GR874-K—Order 017-0028-00 **$125**

Power Divider GR874-TPD—Order 017-0082-00 **$800**

Adapters—
(GR to BNC) Order 017-0063-00 **$55**
(Probe Tip-to-BNC) Order 013-0084-01 **$10**
(Probe Tip-to-GR) Order 017-0076-00 **$65**
(Probe Tip-to-GR Terminated) Order 017-0088-00 **$70**

RECOMMENDED PROBES

P6056 10X Passive **$200**
P6057 100X Passive **$195**

OPTIONAL SAMPLING HEAD ACCESSORIES

With SMA (3 mm) Connectors

50-Ω Attenuators—
(2X) Order 015-1001-00 **$150**
(5X) Order 015-1002-00 **$150**
(10X) Order 015-1003-00 **$155**

50-Ω Termination—Order 015-1004-00 **$75**

50-Ω Signal Cables—
(2 ns) Order 015-1005-00 **$120**
(5 ns) Order 015-1006-00 **$180**

Adapters—
(Male-to-GR874) Order 015-1007-00 **$130**
(Female-to-GR874) Order 015-1008-00 **$125**
(Male-to-N Female) Order 015-1009-00 **$34**
(Male-to-7 mm) Order 015-1010-00 **$215**
(Male-to-Male) Order 015-1011-00 **$25**
(Female-to-Female) Order 015-1012-00 **$11**

Coupling Capacitor—Order 015-1013-00 **$230**

50-Ω Power Divider T—Order 015-1014-00 **$255**

500-ps 50-Ω Semi-Rigid Cable—Order 015-1015-00 **$30**

SMA Adapters—
(T) Order 015-1016-00 **$41**
(Male-to-BNC Female) Order 015-1018-00 **$10.25**

1-ns 50-Ω Cable—Order 015-1019-00 **$150**

SMA Terminations—
(Male Short-Circuit) Order 015-1020-00 **$21**
(Female Short-Circuit) Order 015-1021-00 **$27**
(Male 50 Ω) Order 015-1022-00 **$40**

With 50-Ω BNC Connectors

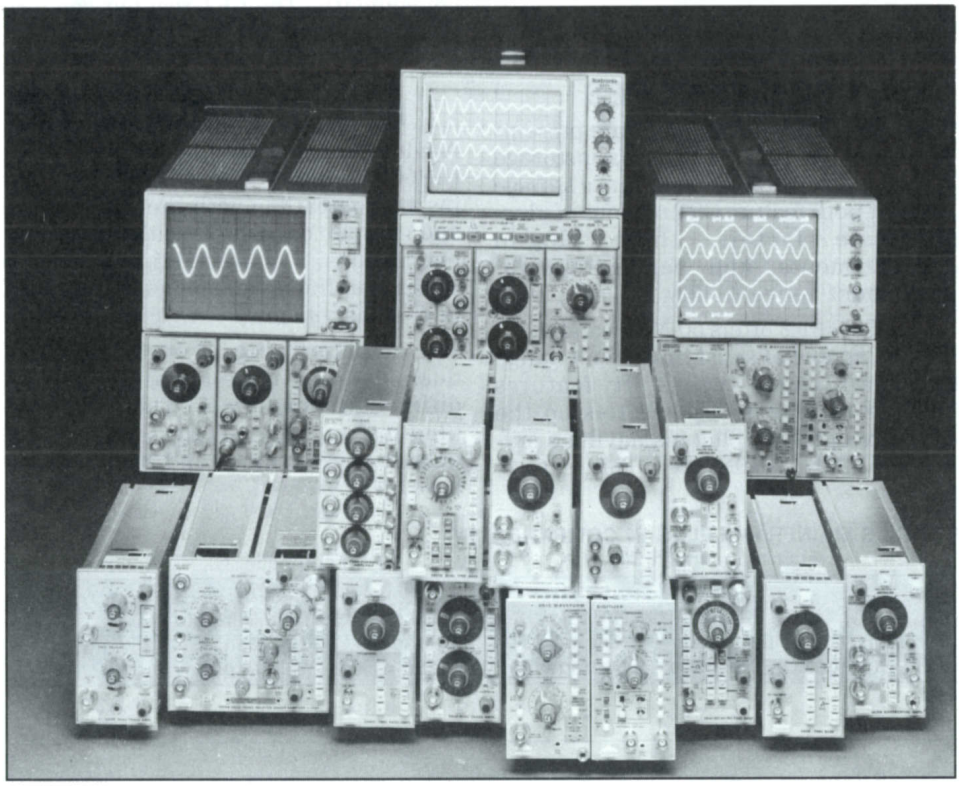
Feed-Through Termination—Order 011-0049-01 **$32**

Feed-Through (5 W)—Order 011-0099-00 **$55**

Attenuators—
(2X) Order 011-0069-02 **$45**
(2.5X) Order 011-0076-02 **$44**
(5X) Order 011-0060-02 **$44**
(10X) Order 011-0059-02 **$45**

Coaxial Cables—
(18 in) Order 012-0076-00 **$17.50**
(42 in) Order 012-0057-01 **$18.50**

5000-SERIES INSTRUMENTS



CONTENTS

5440/R5440 General Purpose . . . 290
5441/R5441 Storage 290
5110/R5110 Single Beam 293
5111A/R5111A Single-Beam Storage 293
5113/R5113 Dual-Beam Storage . . 293
Plug-Ins 291, 295
High-Performance Digitizing Mainframes 354

- **Low Cost**
- **Seven Oscilloscope Models**
- **2-MHz, 10-MHz, or 50-MHz Bandwidth**
- **10-μV/Div Sensitivity**
- **Wide Choice of Plug-Ins**
- **One- to Eight-Trace Capability**
- **Digital, Dual-Beam, & Storage Displays**
- **Large 6.5-Inch CRT (8×10 Div)**
- **CRT Readout (5400 Series and 5D10)**
- **Delayed-Sweep Time Bases**
- **Y-T or X-Y Operation**
- **Bench-to-Rack Convertibility**

The 5000-Series plug-in oscilloscope family is designed to provide maximum versatility and performance at the lowest possible price.

The seven 5100 Series mainframes provide real-time bandwidth to 2 MHz, sensitivity to 10 microvolts per division, CRT and digital storage, dual-sweep operation, and more.

The 5223 digitizing mainframe with the 5B25N time base provides digitization of signals to 10 MHz with optional GPIB interface.

The 5400-Series mainframes provide all of the capabilities of the 5100-Series mainframes plus 50-MHz bandwidth, variable-persistence storage, and CRT readout of vertical and horizontal scale factors.

5000-SERIES SELECTION GUIDE

Features	5440/R5440 Nonstorage With Readout	5441/R5441 Variable-Persistence Storage W/Readout	5110/R5110 Nonstorage	5111A/R5111A Bistable Storage	5113/R5113 Dual-Beam Bistable Storage
Bandwidth	50 MHz	50 MHz	2 MHz	2 MHz	2 MHz
Minimum Deflection Factor	5 mV/div at BW 10 μV/div 0.5 mA/div	5 mV/div at BW 10 μV/div 0.5 mA/div	1 mV/div at BW 10 μV/div 0.5 mA/div	1 mV/div at BW 10 μV/div 0.5 mA/div	1 mV/div at BW 10 μV/div 0.5 mA/div
Maximum Sweep Rate	10 ns/div	10 ns/div	100 ns/div	100 ns/div	100 ns/div
Eight Traces	✓	✓	✓	✓	✓ Dual Beam
Delayed Sweep	✓	✓	✓	✓	✓
Prices*1 begin at	$3,835/$3,910	$6,070/$5,980	$2,095/$2,185	$3,125/$3,120	$4,375/$4,550

*1 *Price does not include plug-ins.*

5100-SERIES OSCILLOSCOPES

Three 5100-Series oscilloscope mainframes are available: the 5110 single-beam nonstorage mainframe, the 5111A single-beam storage mainframe, and the 5113 dual-beam storage mainframe. All of these mainframes feature 2-MHz vertical systems with large 6½-inch CRTs.

Each 5000-Series mainframe houses up to three plug-in units. For conventional Y-T operation, the left and middle plug-ins are amplifier units and the right plug-in is a time-base unit. An amplifier unit may be used in the right plug-in compartment to provide X-Y operation to the full sensitivity of the amplifier unit used. A dual-trace amplifier unit in the right compartment can provide fully independent, dual X-Y displays.

For information on the 5223 Digitizing Oscilloscope and its associated 5B25N time-base unit, see the Digitizer section.

5400-SERIES OSCILLOSCOPES

Two 5400-Series display units are presently available: A single-beam, nonstorage display and a variable-persistence storage display. Both feature CRT readout of plug-in scale factors, three plug-in compartments, and benchmount-to-rackmount convertibility.

The 5400 Series offers 50-MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be externally accessed (Option 03).

PLUG-IN VERSATILITY

A wide choice of plug-ins is available in the 5000-Series family. All of these plug-ins are compatible with the 5400 Series, and most are compatible with 5100-Series mainframes. Compatibilities of 5000-Series mainframes and plug-ins are shown in the chart below.

The amplifier plug-ins include single-, dual-, and four-trace units, and various differential amplifiers. The time-base plug-ins include single-, dual-, and delaying-sweep units, and a digital time base.

5000-SERIES MAINFRAME/PLUG-IN COMPATIBILITY

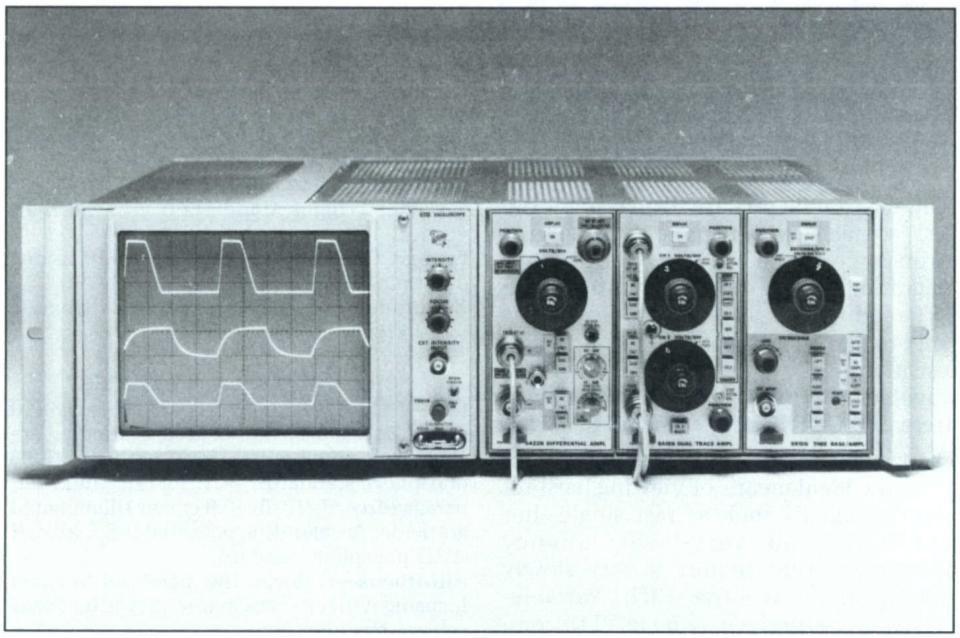
F=Full compatibility L=Limited compatibility 0=No compatibility

Plug-Ins	5110 2 MHz Nonstorage	5111A 2 MHz CRT Storage	5113 2 MHz Dual Beam CRT Storage	5223 10 MHz Digital Storage	5440 50 MHz Nonstorage W/Readout	5441 50 MHz Variable Persistence W/Readout	Price
5A14N Four Trace, 1 MHz, 1 mV/div	F	F	F	F	L*1	L*1	$1,685
5A15N Single Trace, 2 MHz, 1 mV/div	F	F	F	F	L*1	L*1	$405
5A18N Dual Trace, 2 MHz, 1 mV/div	F	F	F	F	L*1	L*1	$845
5A19N Single-Trace Differential, 2 MHz, 1 mV/div	F	F	F	F	L*1	L*1	$495
5A21N Single-Trace Differential, 1 MHz, 50 μV/div, 0.5 mA/div	F	F	F	F	L*1	L*1	$660
5A22N Single-Trace Differential, 1 MHz, 10 μV/div	F	F	F	F	L*1	L*1	$1,240
5A26 Dual-Trace Differential, 1 MHz, 50 μV/div	F	F	F	F	F	F	$1,390
5A38 Dual Trace, 35 MHz, 10 mV/div	0	0	0	F	F	F	$945
5A48 Dual Trace, 50 MHz, 1 mV/div	0	0	0	F	F	F	$1,260
5B10N Single-Sweep Time Base/ Amplifier, 1 μs to 5 s	F	F	F	L*2	L*1	L*1	$640
5B12N Dual-Sweep Time Base, A-1 μs to 5 s, B-2 μs to 0.5 s	F	F	F	L*2	L*1	L*1	$1,355
5B25N Digital Time Base for 5223, 0.2 μs to 5 s	0	0	0	F	L*1	L*1	$1,230
5B40 Single-Sweep Time Base, 0.1 μs to 5 s	0	0	0	L*2	F	F	$895
5B42 Delaying Time Base, A-0.1 μs to 5 s, B-0.1 μs to 0.5 s	0	0	0	L*2	F	F	$1,580
5CT1N Semiconductor Curve Tracer	F	F	F	F	L*1	L*1	$1,125
5D10 Waveform Digitizer	F	F	F	L*2	F	F	$2,420

*1 *Plug-ins with an "N" suffix do not implement the readout feature of the 5440 and 5441.*
*2 *Only 5B25N implements the digital storage feature of the 5223.*

APPLICATION NOTES FOR 5000 SERIES

Title	Description	Order
Biophysical Data Retrieval, The Digitizing Approach	5223/5B25N/5A18N Roll mode, chart recorder output.	52-W-4462-1
Interpreting Mechanical Measurements With the Plug-In Oscilloscope	5111/5A22N/5A18N Transducer measurements and storage.	52-A-3533-1
Simultaneous Display of Two Independent X-Y Signal Pairs	5111/5A15/5A15N/5A18N. Dual X-Y techniques, engine analysis.	52-AX-4114
Simultaneous X-Y, Y-T Displays	5111/5A15/5A15N/5B12N. X-Y, Y-T techniques. Biomedical application.	52-AX-4113
Custom Plug-In Ideas for 5000 Series Scopes	Recommended starter note for customers considering custom plug-in project.	52-AX-3758
A High Resolution 60 Hz Notch Filter	Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum.	52-AX-4031
A True RMS Converter	Construction project using thermal true RMS converter module in our blank plug-in kit. Measures true RMS up to 200 V RMS.	52-AX-4112



5000-Series rackmount oscilloscopes and cabinet-to-rackmount kits include complete slideout tracks and mounting hardware interface with standard 19-inch racks.

5000 SERIES PLUG-IN/PROBE COMPATIBILITY

Plug-In	Probe	Attenuation	Features
5A14N	P6101A	1X	Full bandwidth
5A15N	P6102A	10X	Full bandwidth
5A18N	P6062B	1X–10X	Switchable attenuation,
5D10			ground-reference button
5A21N	P6101A	1X	Full bandwidth
5A22N	P6102A	10X	Full bandwidth
5A26	P6062B	1X–10X	Switchable attenuation, ground-reference button
	P6055	10X	Variable attenuation for high CMRR in differential operation
5A38	P6101A	1X	Reduced bandwidth
5A48	P6105A	10X	Full bandwidth
	P6062B	1X–10X	Switchable attenuation, ground-reference button, reduced bandwidth at 1X

See Probe Section for complete descriptions.

Two special-purpose plug-ins are also available. The 5CT1N is a semiconductor curve-tracer plug-in. It allows characteristic curves of transistors, FETs, diodes, and other semiconductor devices to be displayed on the CRT.

The 5D10 is a dual-channel, digital-storage unit with cursors, CRT scale-factor readout, roll mode, and plotter output.

OPTIONAL ACCESSORIES

CART

K213 Lab Instrument Cart—For cabinet models. Plug-in storage available as Option 12. See Accessories section for more information.

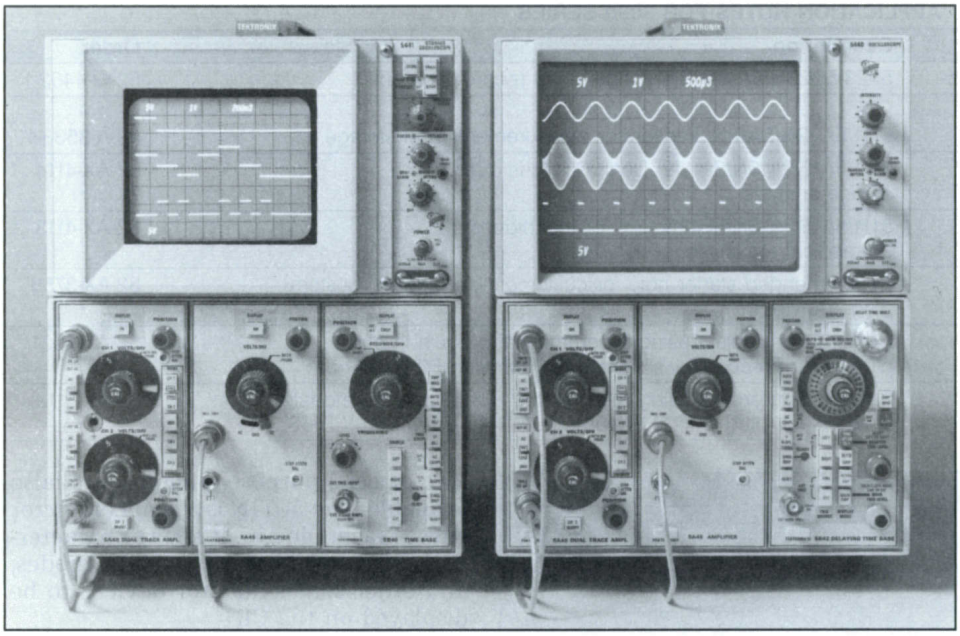
CAMERAS

C-7, C-5C or C-4 Option 02—For all 5100 Series. Suitable for repetitive or stored traces.
C-59A (G or P)—General Purpose. For 5100 Series storage scopes and 5400 Series.

For full details, see Camera section.

Blank Plug-In Kit—	
Order 040-0818-03	$130
Blank Panel—Order 016-0452-00	$25
Viewing Hoods—	
Order 016-0154-00	$43
Order 016-0260-00 (Folding)	$27
Protective Cover—	
Order 016-0544-00	$18

For full details, see Accessories section.



5440/R5440 General Purpose
5441/R5441 Storage

- **DC to 50 MHz**
- **CRT Readout**
- **Three Plug-In Flexibility**
- **Wide Choice of Plug-Ins**
- **Bench-to-Rack Convertibility**
- **Low Cost**

See 5000-Series Reference section for available Application Notes.

TYPICAL APPLICATIONS

5440/R5440
Electrical Engineering
Component Testing
Ultrasonics

5441/R5441 Features

- **5-Div/μs Stored Writing Speed**
- **Variable-Persistence Storage**

TYPICAL APPLICATIONS

Ultrasonics
Low-Power Laser
Fiber Optics

The 5440 and 5441 combine versatility and low cost in a 50-MHz general-purpose, plug-in oscilloscope. These oscilloscopes feature CRT readout of plug-in scale factors, sensitivities to 10 microvolts per division, display of up to eight different signals at two different sweep rates, a three plug-in mainframe, a wide choice of plug-ins, and bench-to-rack convertibility.

Plug-in scale factors are displayed on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. The CRT readout can also be accessed externally to allow the display of dates, times, test numbers, etc., along with displayed waveforms. (Order Option 03, User Addressable CRT Readout.)

The variable persistence of the 5441 provides the ideal means of viewing hard-to-observe signals such as fast single-shot transients and very-low-frequency phenomena that require a very slowly moving trace on the CRT. Variable-persistence storage may be used to completely eliminate the flicker inherent in low-rep-rate traces. With the 5441, the viewing time at normal intensity for any trace can be varied from a fraction of a second to more than five minutes. At lowered intensity (SAVE mode), signals may be viewed for up to an hour.

In addition to permitting viewing of single-shot and low-frequency phenomena, the variable persistence of the 5441 may also be used to suppress the random noise that obscures the true waveform in signals with low signal-to-noise ratio.

The wide variety of plug-ins allows an oscilloscope/plug-in configuration to meet your current and future needs. All of the plug-ins in the 5000 Series are compatible with the 5440 and 5441.*[1]

*[1] *Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout. The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

CHARACTERISTICS

VERTICAL SYSTEM

Characteristics are common to the 5440/R5440 and 5441/R5441 unless otherwise indicated.

Channels—Left and center plug-in compartments. Compatible with all 5000-Series plug-ins. CRT readout is not available with plug-ins having a suffix N (5A18N, etc.).

Bandwidth—Up to 50 MHz, determined by plug-in unit. See 5000-Series Reference section.

Deflection Factor—Determined by plug-in unit. See 5000-Series Reference section.

Chopped Mode—The oscilloscope will chop between channels at ≈ 25 kHz to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode—Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right plug-in compartment. Compatible with all 5000-Series plug-ins. CRT readout is not available for plug-ins with a Suffix N (5B10N, etc.).

Internal Trigger Mode—Left vertical, right vertical.

Fastest Calibrated Sweep Rate—10 ns/div, determined by plug-in.

X-Y Mode—Phase shift is within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

CRT—5440/R5440: Internal parallax-free 8×10 div (1.22 cm/div) illuminated graticule. Accelerating potential is 15 kV with GH (P31) phosphor standard. 5441/R5441: Internal, parallax-free, 8×10 div (0.9 cm/div) illuminated graticule. Accelerating potential is 8.5 kV. GH (P31) phosphor standard.

Autofocus—Reduces the need for manual focusing with changes in intensity after focus control has been set.

External Intensity Input—+5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range is dc to 2 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

Beam Finder—Brings offscreen trace into graticule area.

5440/R5440 FEATURES

Minimum Photographic Writing Speed—Using Polaroid film 20,000 ASA without film fogging. Writing speed can be increased with the Tektronix Writing Speed Enhancer. (See Accessories section for more information.)

Optional Phosphors (Specify)—GM (P7) or BE (P11).

5441/R5441 FEATURES

Persistence—Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

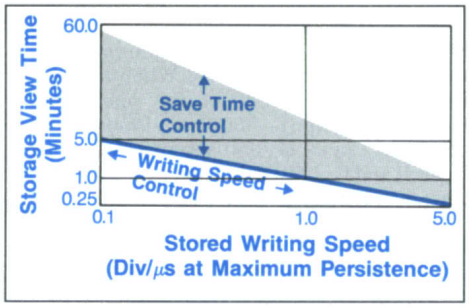
PHOTOGRAPHIC WRITING SPEED

Writing Speed cm/μs				Camera	Lens
GH (P31) Phosphor		BE (P11) Phosphor			
20,000 ASA	3000 ASA	20,000 ASA	3000 ASA		
180	90	245	125	C-59P	f/2.8 0.67 mag
330	160	450	230	C-50P*1	f/2.8 0.7 mag

*1 *Slight cropping of the graticule corners. Requires optional battery pack (016-0270-02) for operation with the 5440.*

Maximum Stored Writing Speed—Writing speed >5 div/μs for a view time of 15 s.
Storage View Time—The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed, the view time is 15 seconds with the writing-speed control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to five minutes (refer to chart below).
Save Mode—Extends view time of stored displays up to one hour; prevents erasure of stored display and storage of unwanted displays.
Erase Time—0.5 s ±10%.



STORED WRITING SPEED (Div/μs at Maximum Persistence)

CALIBRATOR

Voltage—400 mV within 1%.
Current Output—4 mA within 1%. Frequency is two times the power-line frequency.

POWER REQUIREMENTS

Line-Voltage Ranges—100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac), internally selected with quick-change jumpers.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—100 W at 120 V ac, 60 Hz.

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −40 to +70°C.
Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Ordering information is common to the 5440/R5440 and 5441/R5441 units unless otherwise noted.

5440 General-Purpose Oscilloscope **$3,835**
Includes: Instruction manual (070-2139-01).
R5440 Rackmount Oscilloscope **$3,910**
Includes: Same as 5440.
5441 Storage Oscilloscope **$6,070**
Includes: Instruction manual (070-2140-01).
R5441 Rackmount Oscilloscope **$5,980**
Includes: Same as 5441.

OPTIONS

Option 01—Without CRT Readout. **NC**
Option 03—User-Addressable CRT Readout. Up to 20 user-selected characters may be displayed in the CRT readout for additional test information such as time, date, device tested, test number, etc. Especially useful for documenting photographs. Programming of characters is done by external resistors and switches. **+$150**
Option 04—(5440/5441 only) Protective Panel Cover. **+$40**
Option 76—(5440/R5440 only) GM (P7) Phosphor. **+$50**
Option 78—(5440/R5440 only) BE (P11) Phosphor. **+$50**

CONVERSION KITS

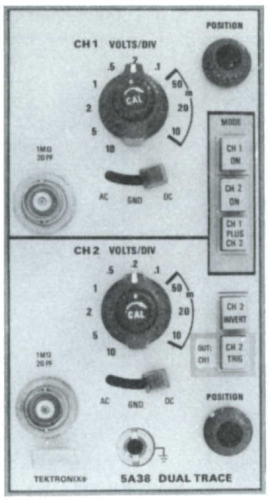
CRT Readout—Order 040-0691-02 **$580**
Cabinet-to-Rackmount—Order 040-0583-03 **$215**
Rackmount-to-Cabinet—Order 040-0584-04 **$200**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins—See 5000-Series Reference section and Accessories section.
Recommended Probes—See 5000-Series Reference section and Accessories section.
Recommended Cameras—See 5000-Series Reference section and Accessories section.
Recommended Cart—K213 Option 12. See 5000-Series Reference section and Accessories section.



5A38 Dual-Trace Amplifier

5A38

- **DC to 35-MHz Bandwidth**
- **10-mV to 10-V/Div Calibrated Deflection Factors**

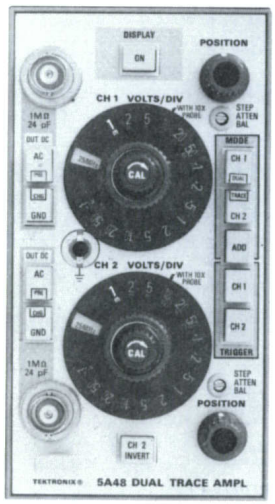
The 5A38 is a dual-trace, 35-MHz plug-in amplifier for use only in the 5223 and the 5400-Series mainframes. It features 10-mV/div sensitivity and CRT readout of deflection factor.*1

CHARACTERISTICS

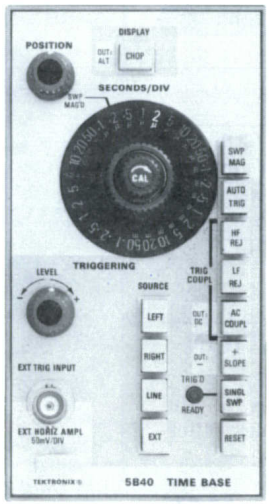
Bandwidth—DC Coupled: To ≥35 MHz. Lower End Response, AC Coupled: ≤10 Hz.
Deflection Factors—Calibrated: 10 mV to 10 V/div in a 1-2-5 sequence. Accuracy: is ≤3% from 15 to 35°C, 4% from 0 to +50°C. Uncalibrated: Variable is continuous between steps to at least 25 V/div.
Input R and C—1 MΩ paralleled by ≈20 pF.
Maximum Input Voltage—DC Coupled: 250 V (dc+peak ac). AC Coupled: 500 V (dc + peak ac). AC Component: 500 V p-p maximum at 1 kHz or less.
Stability—≤0.3 mV vertical shift in any one minute after one-hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.
Display Modes—Channel 1 only, Channel 2 only (normal or inverted), Dual Trace, and Added. Alternated or chopped operation determined by time-base plug-in. Internal trigger selectable from Channel 1 or Channel 2.
Rise Time—≤10 ns.
Channel Isolation—≥50:1 to 35 MHz with both traces displayed.

ORDERING INFORMATION

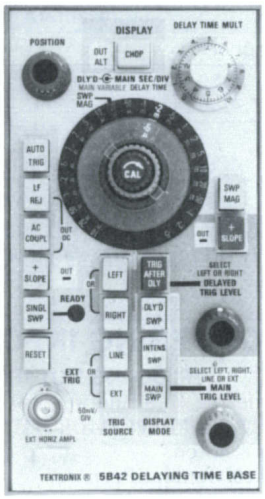
5A38 Dual-Trace Amplifier **$945**
Includes: Instruction manual (070-1694-00).
*1 *CRT readout not functional in 5223.*
For floating measurements, order A6902B Isolator. See Accessories section for complete description.



5A48 Dual-Trace Amplifier



5B40 Time Base



5B42 Delaying Time Base

5A48

- **DC to 50-MHz Bandwidth**
- **1-mV to 10-V/Div Calibrated Deflection Factors**

The 5A48 is a dual-trace, 50-MHz plug-in amplifier for use in the 5223 and the 5400-Series mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.*1

CHARACTERISTICS

Bandwidth—DC Coupled: DC to at least 50 MHz at 5 mV to 10 V/div, dc to at least 25 MHz at 1 and 2 mV/div (3 dB down). AC coupled: 10 Hz or less (1 Hz with 10X probe) at all deflection factors (3 dB down).
Deflection Factors—Calibrated: 1 mV to 10 V/div in a 1-2-5 sequence. Accuracy: ≤5% at 1 and 2 mV/div; ≤3% from 5 mV to 10 V/div from +15 to +35°C; ≤4% from 5 mV to 10 V/div from 0 to +50°C. Uncalibrated: Variable is continuous between steps to at least 25 V/div.
Input R and C—1 MΩ within 1% paralleled by ≈24 pF.
Maximum Input Voltage—DC Coupled: 250 V (dc +peak ac). AC Coupled: 500 V (dc +peak ac). AC Component: 500 V p-p maximum, 1 kHz or less.
Stability—≤0.3 mV vertical shift in any one minute after one-hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.
Display Modes—Channel 1 only, Channel 2 only (normal or inverted), Dual trace, Added, Alternated, Chopped (determined by time-base plug-in, horizontal compartment). Internal Trigger Source: Selectable from Channel 1 or Channel 2.
Rise Time—7 ns or less (5 mV to 10 V/div), 14 ns or less (1 and 2 mV/div).

*1 *CRT readout not functional in 5223.*

ORDERING INFORMATION

5A48 Dual-Trace Amplifier **$1,260**
Includes: Instruction manual (070-1450-00).

RECOMMENDED PROBES

(See 5000-Series Reference section and Accessories section.)
P6105A—10X Passive. See Accessories section. **$93**
For floating measurements, order A6902B Isolator. See Accessories section for complete description.

5B40/5B42

- **Single Sweep**
- **10-ns to 5-s/Div Calibrated Time Base**
- **Triggering to 50 MHz**

The 5B40/5B42 Time Bases are designed for use in 5400-Series mainframes. They feature sweep rates from 10 ns to 5 s/div and CRT readout of the sweep rate selected. The 5B42 also features delayed-sweep rates up to 10 ns/div.

CHARACTERISTICS

The following characteristics are the same for the 5B40 and 5B42 unless otherwise noted.
Sweep Rate—0.1 μs to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.
Sweep Accuracy—Measured in 5400-Series oscilloscope over center eight graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

	Unmagnified		Magnified	
Time/Div	+15 to +35°C	0 to +50°C	+15 to +35°C	0 to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 and 2 s/div, 0.2 and 0.1 μs/div	4%	5%	5%	6.5%

TRIGGERING

Triggering Sensitivity

Coupling	Frequency Range	Minimum Signal Required Internal	External
DC 5400 ampl	DC to 10 MHz	0.4 div*1	60 mV*1
		0.4 div*2	100 mV*2
5400 ampl	10 MHz to 60 MHz	1.0 div*1	150 mV*1
		1.0 div*1	400 mV*2
5100 ampl	DC to 2 MHz	0.4 div*2	100 mV*2
AC	Trigger requirements increase below 50 Hz		
LF Rej	Trigger requirements increase below 7.5 kHz		
HF Rej	Trigger requirements increase above 50 kHz*1		

*1 *5B40 only.* *2 *5B42 only.*

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.
Ext Trigger Input—Maximum Input Voltage: 350 V dc +peak ac, 350 V p-p ac at ≤1 kHz. Input R and C: 1 MΩ paralleled by ≈24 pF. Trigger Level Range: ≥±1.5 V (5B40) and ±2.5 V (5B42).
Ext Horizontal Input—Deflection Factor: 50 mV/div ±3%. Input R and C: 1 MΩ paralleled by ≈24 pF. DC-Coupled Bandwidth: DC to ≥2 MHz. AC-Coupled Lower Response: ≤50 Hz. Maximum Input Voltage: 350 V (dc +peak ac) or 350 V p-p ac at ≤1 kHz.

DELAYING SWEEP (5B42 ONLY)

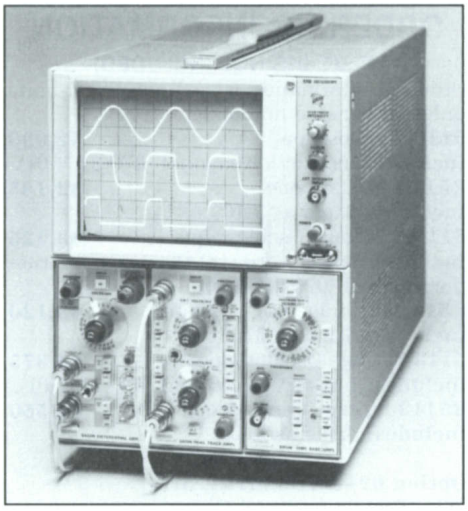
Delay Time Multiplier Range—0.2 to 10 times the Time/Div setting.
Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale to 1 s to 5 s delay time.
Jitter—<0.05% of the time represented by one division of delaying sweep selected.

DELAYED SWEEP (5B42 ONLY)

Sweep Rate—0.1 μs to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.
Sweep Accuracy—Measured over the center eight divisions. Same as undelayed sweep.
Triggering—The same as the internal triggering specifications in the table above.

ORDERING INFORMATION

5B40 Time Base **$895**
Includes: Instruction manual (070-1742-00).
5B42 Delaying Time Base **$1,580**
Includes: Instruction manual (070-1447-00).



5100 -Series Oscilloscopes

- **Low Cost**
- **DC to 2 MHz**
- **Wide Choice of Plug-Ins**
- **Rear-Panel Signal Outputs Optional**

See 5000-Series Reference section for available Application Notes.

5110/R5110

- **Lowest Cost Single-Beam Nonstorage Oscilloscope With Plug-In Configurability**
- **8 Channels at 1 mV/Div, 4 Channels at 50 μV/Div, 2 Channels at 10 μV/Div, With Appropriate Amplifiers**

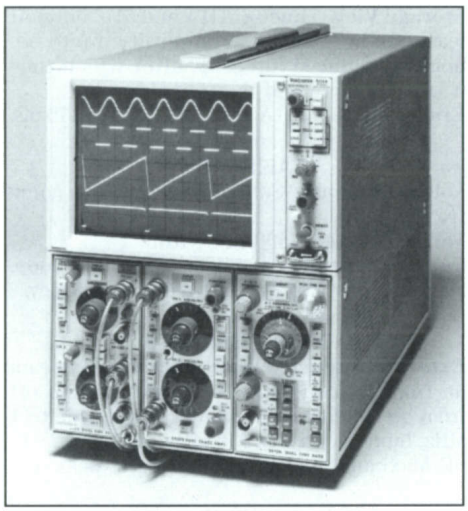
TYPICAL APPLICATIONS

Biomedical Research
Electromechanical Design and Test

The 5110 is a single-beam nonstorage oscilloscope featuring a large 6½-inch diagonal (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four-channel differential at 50 μV/div, or eight-channel displays at 1 mV/div. You can also choose from single-trace or dual-trace basic amplifiers and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and the 5B12N dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.



5111A/R5111A

- **Single-Beam Bistable-Storage Oscilloscope**
- **Split-Screen Display**
- **Stored Writing Speed to 800 Div/ms in Enhanced Mode (Option 03)**

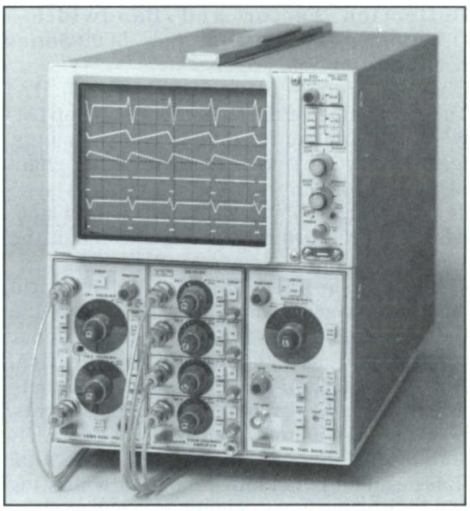
TYPICAL APPLICATIONS

Electromechanical Design and Test
Vibration Analysis

The 5111A is a single-beam, split-screen, bistable-storage oscilloscope with a large 6½-inch diagonal display. The 5111A extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography. It is particularly useful for recording low- and medium-frequency signals.

The standard 5111A provides writing speeds to 50 div/ms; Option 03 extends the writing speed to 800 div/ms, suitable for capturing a single-shot display of a 60-kHz sine wave four divisions in amplitude.

Up to eight traces can be displayed and stored simultaneously with two 5A14N amplifier plug-in units. When using two amplifiers and the 5B12N dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.



5113/R5113

- **Dual-Beam Bistable-Storage Oscilloscope**
- **Split-Screen Display**
- **Two Independent Vertical Systems**
- **Two Single-Shot Display Signals**
- **Display Without Time-Sharing**
- **Stored Writing Speed ≥20 Div/ms**

TYPICAL APPLICATIONS

Biomedical Research
Low-Repetition Rate Observation

The 5113 is a dual-beam, bistable-storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms. View time is at least one hour at normal intensity and can be increased to ten hours at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing-rate limits of the system. Both beams are driven by one set of horizontal deflection plates.

The 5113 is particularly useful in biomedical research where low repetition-rate stimulus/response potentials need to be simultaneously observed and recorded.

5100 -Series Oscilloscopes

CHARACTERISTICS

Characteristics are the same for the 5110/R5110, 5111A/R5111A, and 5113/R5113 unless otherwise indicated.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments. Compatible with all 5000-Series plug-ins. See 5000-Series Reference section.

Deflection Factor and Bandwidth—Determined by plug-in. See 5000-Series Reference section.

Chopped Mode—(5110/R5110, 5111A/R5111A) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time-base unit.

Chopped Mode—(5113/R5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments, respectively. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≈5 μs, consisting of 4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time-base unit.

Alternate Mode—(5110/R5110, 5111A/R5111A) Each amplifier plug-in is swept twice before switching to the next. Single-trace amplifiers are swept twice. Each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

Alternate Mode—(5113/R5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel—Right plug-in compartment. Compatible with all 5100-Series plug-ins. See 5000-Series Reference section.

Fastest Calibrated Sweep Rate—0.1 μs/div (X10 mag) with 5B10N or 5B12N; 10 μs/div (X10 mag) with 5D10.

X-Y Mode—Phase shift is within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

CRT—Internal 8 x 10 div (1.27 cm/div) parallax-free, nonilluminated graticule. Illuminated graticule available at extra cost.

Accelerating Potential—5110/R5110, 5111A/R5111A, 5113/R5113: 3.5 kV.

Standard Phosphor—5110/R5110: GH (P31). 5111A/R5111A, 5113/R5113: Equivalent to GJ (P1).

Optional Phosphors (Specify)—(5110/R5110 only) GM (P7) or BE (P11).

Beam Finder—Aids in locating an off-screen signal.

Maximum Stored Writing Speed—(5111A and 5113 only) 5111A/R5111A: At least 20 div/ms in the Normal Mode and 50 div/ms in the Enhanced Mode. 5113/R5113: At least 20 div/ms.

With Option 03, Fast-Writing-Speed CRT—(5111A and 5113 only) At least 200 div/ms (center 6 x 8 div) in the Normal Mode and 800 div/ms (center 6 x 8 div) in the Enhanced Mode.

Storage View Time—(5111A and 5113 only) At least one hour at normal intensity; up to ten hours at reduced intensity, after which time it may be increased to original level.

Erase Time—(5111A and 5113 only) ≈250 ms.

CALIBRATOR

Voltage Output—Square wave, positive going from ground.

Voltage Range—400 mV within 1%.

Current Output—4 mA with current loop. Frequency is two times the line frequency.

OUTPUTS/INPUTS

External Intensity Input—+5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range is dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

POWER REQUIREMENTS

Line-Voltage Ranges—100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick-change jumpers.

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—110 W.

ENVIRONMENTAL

Ambient Temperature—5110/5111A/5113: Operating, 0 to +50°C; nonoperating, −40 to +70°C.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	213	8.4	483	19.0
Height	302	11.9	135	5.3
Depth	518	20.4	483	19.0
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	10.4	23.0	10.9	24.0
Shipping	14.5	32.0	19.5	43.0

OPTION 07

Rear-Panel Signal Outputs

CHARACTERISTICS

Left and Center Compartments—Two BNC connectors provide access to the CRT-related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output impedance: 1 kΩ.

Right Compartment—Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive going sawtooth, ≥ 5 V. Output Impedance is 1 kΩ. Gate: One BNC connector provides access to TTL-compatible gate. Positive going, coincident with displayed sweep.

X-Y Mode—CRT-related X-Y signals are available at the appropriate rear-panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Ordering information is common to all units unless otherwise noted.

5110 Oscilloscope **$2,095**
Includes: Instruction manual (070-2134-01).

R5110 Oscilloscope **$2,185**
Includes: Same as 5110.

5111A Storage Oscilloscope **$3,125**
Includes: Power cord (161-0066-00); instruction manual (070-3934-00).

R5111A Storage Oscilloscope **$3,120**
Includes: Same as 5111A.

5113 Storage Oscilloscope **$4,375**
Includes: Instruction manual (070-2137-01).

R5113 Storage Oscilloscope **$4,550**
Includes: Same as 5113.

OPTIONS

Option 02—(5110, 5111A, 5113 only) Protective Panel Cover. The cover protects the front panel and knobs during transportation and storage. **+$40**

Option 03—Fast Write CRT increases stored writing speed to 200 div/ms (center 6 x 8 div).
(5111A/R5111A) **+$205**
(5113/R5113A) **+$150**

Option 07—Add Rear-Panel Signals Out. **+$130**

Option 76—(5110, R5110 only) GM (P7) Phosphor. **+$50**

Option 78—(5110, R5110 only) BE (P11) Phosphor. **+$50**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit—Order 040-0583-03 **$215**

Rackmount-to-Cabinet Conversion Kit—Order 040-0584-04 **$200**

Protective Panel Cover Kit—(5110, 5111A, 5113 only) Order 040-0620-00 **$40**

Rear Panel Signal Outputs—Order 040-0915-02 **$350**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins—See 5000-Series Reference section and Accessories section.

Recommended Probes—See 5000-Series Reference section and Accessories section.

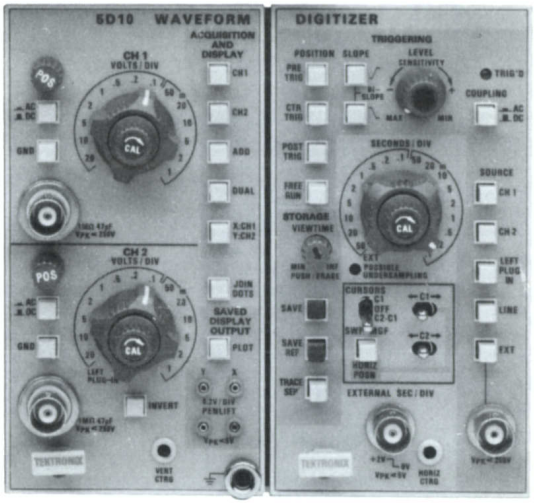
Recommended Cart—K213 Option 12. See Accessories section.

RECOMMENDED CAMERAS
(See Accessories section.)

C-5C—Low cost. **$495**

C-59AP—General purpose for 5100 Series. **$1,375**

C-7—AutoFilm Eject. **$595**



5D10 Digital-Storage Unit

- **Compatible With All 5000-Series Mainframes**
- **Digital Storage**
- **CRT Readout**
- **Powerful Triggering Capability**
- **1% Accuracy**
- **Dual Channel**
- **1-MHz Sample Frequency**
- **Save Reference Waveforms**
- **X-Y Recorder Output**
- **Signal Conditioning via Left Vertical Plug-In**

The 5D10 enhances all Tektronix 5000-Series mainframes by providing digital storage for transient events with frequency components up to 100 kHz for single-channel acquisition and up to 50 kHz for dual-channel acquisition, all in a compact, two-wide plug-in.

CHARACTERISTICS

VERTICAL

Vertical Modes—CH 1, CH 2, Add, Dual, X-Y.
Channel 2 Modes—V/div, Left plug-in.
Deflection Factor—1 mV to 20 V/div in 14 calibrated steps (1-2-5 sequence).
Accuracy—Input to Readout Numbers: 5 mV to 1 V/div ±1%; 1 to 2 mV/div ±2%; 2 to 20 V/div ±2%; Input to CRT graticule ±2%. From Left Vertical Plug-in: Add ±1% to above specifications. Add Mode: Add ±1% to above specifications.
Input R and C—1 MΩ ±0.5% paralleled by ≈47 pF.
Maximum Input— 250 V (dc +peak ac); 250 V p-p ac at 1 kHz or less.
Bandwidth—Single Channel: Suitable from dc to 100 kHz. Dual Channel: Suitable from dc to 50 kHz. AC Coupling: 3 dB point—10 Hz or less (1 Hz with 10X probe).
Common-Mode Rejection—At least 50:1, dc to 100 kHz.
Resolution—Vertical: X-Y or Y-T; 0.04 div (8-bit digitizer). Horizontal: Y-T; 0.01 div (1024 memory locations shared among all traces displayed).
Phase Shift— ≤1.0° phase shift between CH 1 and CH 2, dc to 100 kHz.
Display Output (to X-Y Recorder)—Amplitude: 0.2 V/div ±2%. Speed: Compatible with X-Y recorders with 20 in./s slew rate, or faster. Pen Lift: Isolated switch contacts, SPST (floating); normally open or normally closed selected by internal jumper.

TIME BASE

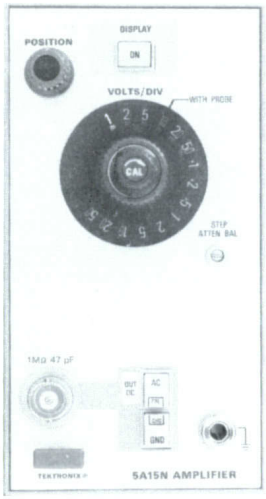
Sweep Rates—0.1 ms to 50 s/div in 18 calibrated steps 1-2-5 sequence (to 10 μs/div with 10X magnifier).
Accuracy—Within ±1% of readout numbers.
External Input—Allows external pulse generator to determine acquisition rate. Accepts TTL levels up to 1-MHz rate.
Possible Under-Sampling Indicator—Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossing of triggering signals.

TRIGGERING

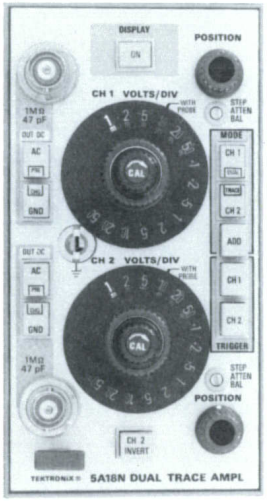
Sources—CH 1, CH 2, left plug-in (via mainframe), line, external.
Coupling—DC, AC.
Sensitivity—External: 100 mV, dc to 50 kHz or pulsewidth >5 μs; 250 mV 50 to 250 kHz or pulsewidth >1 μs. CH 1, CH 2, Left Plug-in: 0.4 div, dc to 50 kHz or pulsewidth >5 μs; 1.0 div, 50 to 250 kHz or pulsewidth >1 μs.
Bislope Trigger—Amplitude, frequency, and pulsewidth specifications apply to absolute value of signal (rectified).
External Trigger Input—Input R and C: 1 MΩ ±2% parelleled by ≈47 pF. Maximum input 250 V (dc +peak ac). 250 V p-p ac at 1 kHz or less.

ORDERING INFORMATION

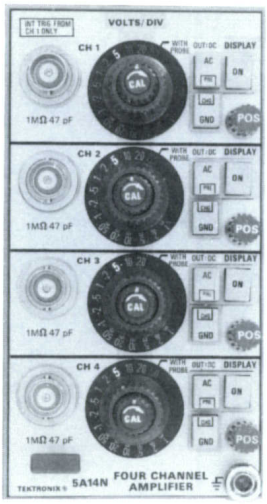
5D10 Waveform Digitizer **$2,420**
Includes: Diagnostics manual (070-4323-00); operator manual (070-3696-01); service manual (070-3697-00).



5A15N Single-Trace Amplifier



5A18N Dual-Trace Amplifier



5A14N Four-Trace Amplifier

5A15N

- **DC to 2-MHz Bandwidth**
- **1 mV to 5 V/Div**

The 5A15N is the simplest of the 5A-Series plug-in amplifiers to use. It provides a bandwidth of dc to 2 MHz in any 5000-Series mainframe at sensitivities to 1 mV/div. Two 5A15Ns may be used in a mainframe to provide dual-trace operation, or to provide 1 mV/div X-Y operation if one of the amplifiers is inserted in the right mainframe compartment.

CHARACTERISTICS

Bandwidth—DC Coupled: DC to at least 2 MHz at all deflection factors. AC Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.
Deflection Factor—Calibrated: 1 mV to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.
Input R and C—1 MΩ within 1% paralleled by ≈47 pF.
Maximum Input—DC Coupled: 350 V (dc + peak ac). AC Coupled: 350 V dc.

ORDERING INFORMATION

5A15N Single-Trace Amplifier **$405**
Includes: Instruction manual (070-1136-00).

RECOMMENDED PROBES

P6101A—1X Passive. **$53**
P6102A—10X Passive. **$65**
P6062B—1X/10X Passive. **$175**

For recommended probes, see 5000-Series Reference section and Accessories section.

5A18N

- **DC to 2-MHz Bandwidth**
- **1 mV to 5 V/Div**

The 5A18N is essentially a dual-trace 5A15N. Bandwidth is dc to 2 MHz in any 5000-Series mainframe at sensitivities to 1 mV/div. The Channel-2 signal may be inverted by means of a front-panel switch to provide difference measurements of two signals in the ADD mode. The internal trigger signal is selectable from Channel 1 or Channel 2 by means of front-panel pushbuttons.

Dual-trace X-Y operation may be obtained with a 5A18N in the right compartment of any 5000-Series mainframe.

CHARACTERISTICS

Bandwidth—DC Coupled: DC to at least 2 MHz at all deflection factors. AC Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.
Deflection Factor—Calibrated: 1 mV to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.
Input R and C—1 MΩ within 1% paralleled by ≈47 pF.
Maximum Input—DC Coupled: 350 V (dc + peak ac). AC Coupled: 350 V dc.
Chopping Rate—25 to 100 kHz depending upon plug-in combinations and number of traces displayed.

ORDERING INFORMATION

5A18N Dual-Trace Amplifier **$845**
Includes: Instruction manual (070-1137-00).

5A14N

- **DC to 1-MHz Bandwidth**
- **1 mV to 5 V/Div**

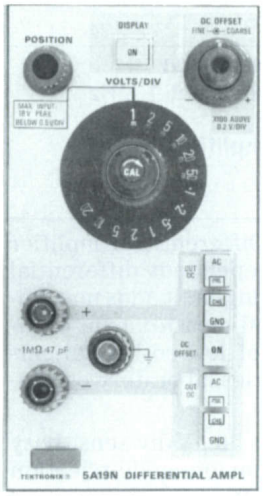
The 5A14N is a four-trace amplifier unit that provides 1-MHz bandwidth and sensitivity to 1 mV/div in any 5000-Series mainframe. Each channel may be displayed separately, or the channels may be alternated or chopped in any combination. The internal triggering signal is available from Channel 1 only. Two 5A14Ns may be combined to provide eight-trace operation in any 5000-Series mainframe.

CHARACTERISTICS

Bandwidth—DC Coupled: DC to at least 1 MHz at all deflection factors. AC Coupled: 2 Hz or less to at least 1 MHz at all deflection factors.
Deflection Factor—Calibrated: 1 mV to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.
Input R and C—1 MΩ within 1% paralleled by ≈47 pF.
Maximum Input—DC Coupled: 350 V (dc + peak ac). AC Coupled: 350 V dc.
Chopping Rate—25 to 100 kHz depending upon plug-in combinations and number of traces displayed.

ORDERING INFORMATION

5A14N Four-Trace Amplifier **$1,685**
Includes: Instruction manual (070-1229-00).



5A19N Differential Amplifier

5A19N

- **DC to 2-MHz Bandwidth**
- **1 mV to 20 V/Div**
- **DC Offset**

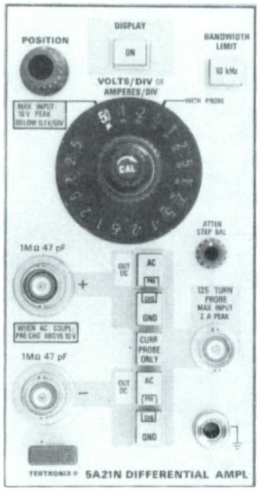
The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of a 5000-Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

CHARACTERISTICS

Bandwidth—DC Coupled: DC to at least 2 MHz at all deflection factors. AC Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.
Deflection Factor—Calibrated: 1 mV to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 50 V/div.
Input R and C—1 MΩ within 0.3% paralleled by ≈47 pF.

Signal and Offset Range

Deflection Factor Settings	1 to 200 mV/div	500 mV to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Maximum DC Coupled Input (DC + Peak AC at 1 kHz or Less)	±350 V	
Maximum AC Coupled Input (AC Voltage)	±350 V	
DC Offset Range	+15 to −15 V	+350 to −350 V



5A21N Differential Amplifier

Common-Mode Rejection Ratio—DC Coupled: 1 to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV to 20 V/div.

ORDERING INFORMATION

5A19N Differential Amplifier **$495**
Includes: Instruction manual (070-1328-00).

For recommended probes, see 5000-Series Reference section and Accessories section.

5A21N

- **DC to 1-MHz Bandwidth**
- **10-kHz Bandwidth Limiter**
- **50 μV to 5 V/Div**
- **100,000:1 CMRR**
- **Voltage- and Current-Probe Inputs**

The 5A21N is a differential amplifier with a current-probe input. In the voltage mode, it provides sensitivities of 50 μV to 5 V/div; with the optional P6021 Current Probe, it provides current sensitivities from 0.5 mA to 0.5 A/Div.

CHARACTERISTICS

Bandwidth—DC Coupled: DC to at least 1 MHz. AC Coupled: 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.
Deflection Factor—Calibrated: 50 μV to 5 V/div in 16 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.
Input R and C—Voltage Mode: 1 MΩ within 0.15% paralleled by ≈47 pF.

Maximum Input Voltage

	DC Coupled	AC Coupled
50 μV to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 10 V peak ac
10 mV to 5 V/div	350 V (dc + peak ac)	

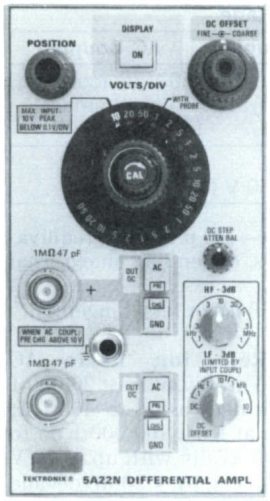
Input Gate Current—100 pA or less (equivalent to 100 μV or less, depending on external loading, at +25 °C.
Displayed Noise—30 μV or less, tangentially measured.
Common-Mode Rejection Ratio—AC Coupled: 50 μV to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. DC Coupled: at least 100,000:1 dc to 30 kHz at 50 and 100 μV/div with up to 20 V p-p sine wave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sine wave.

CURRENT PROBE INPUT (WITH P6021 CURRENT PROBE)

Bandwidth—15 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.
Deflection Factor— Calibrated: 0.5 mA to 0.5 A/div in 10 steps (1-2-5 sequence). Accuracy is within 3%. Uncalibrated: Variable is continuous between steps to at least 1.25 A/div.
Maximum Input Current—4 A p-p (at probe loop) with 125-turn P6021 Current Probe.
Displayed Noise—300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0 to +50 °C.

ORDERING INFORMATION

5A21N Differential Amplifier **$660**
Includes: Instruction manual (070-1139-01).
Option 01—P6021 5-ft current probe. **+$315**



5A22N Differential Amplifier

5A22N

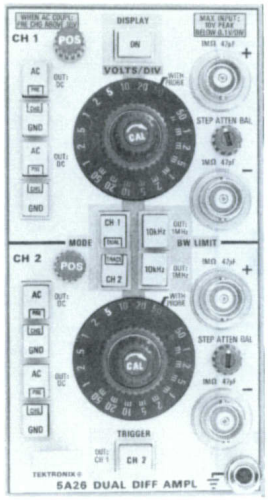
- **DC to 1-MHz Bandwidth**
- **10 μV to 5 V/Div**
- **100,000:1 CMRR**
- **Selectable Upper and Lower −3 dB Points**
- **DC Offset**

The 5A22N is the most versatile of the 5000-Series differential amplifiers. It features front-panel selectable filtering that enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. DC offset at full bandwidth is available for viewing signals riding on a dc component, such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

CHARACTERISTICS

Bandwidth—HF −3 dB Point: Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz accuracy is within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF −3 dB Point: Selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz. Accuracy is within 20% of selected frequency. AC Coupled: 2 Hz or less.
Deflection Factor—Calibrated: 10 μV to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.
Input R and C—1 MΩ within 0.15% paralleled by ≈47 pF.
Maximum Input Gate Current—200 pA or less.
Displayed Noise—20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.



5A26 Dual Differential Amplifier

Overdrive Recovery—10 μs or less to recover to within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.
Drift With Temperature—100 μV/°C or less.
Common-Mode Rejection Ratio—AC Coupled: 10 μV to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. DC Coupled: At least 100,000:1, dc to 30 kHz from 10 to 100 μV/div with up to 20 V p-p sine wave, decreasing by <20 dB/decade on sensitivity ranges up through 50 mV/div. From 100 mV to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sine wave.

Signal and Offset Range

Deflection Factor Settings	10 μV to 50 mV/Div	0.1 V to 5 V/Div
Common-Mode Signal Range	±10 V	±350 V
Maximum DC Coupled Input (dc + peak ac at 1 kHz or less)	±12 V	±350 V
Maximum AC Coupled Input (dc voltage)	±350 V DC rejection, at least 4×10^6:1	
DC Offset Range	+0.5 to −0.5 V	+50 to −50 V

ORDERING INFORMATION

5A22N Differential Amplifier **$1,240**
Includes: Instruction manual (070-1230-00).

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400-Series mainframes only). Contact your local Tektronix Sales Engineer for details.

5A26

- **DC to 1-MHz Bandwidth**
- **50 μV/Div Sensitivity at 1 MHz**
- **100,000:1 CMRR**
- **2 Differential Amplifiers in One Plug-In**
- **CRT Readout**

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential-measurement capability to the line of low-cost, high-performance 5000-Series laboratory oscilloscopes.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode-rejection ratio, CRT readout in any standard 5400-Series mainframe, trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electro-mechanical fields, education, and component manufacturing.

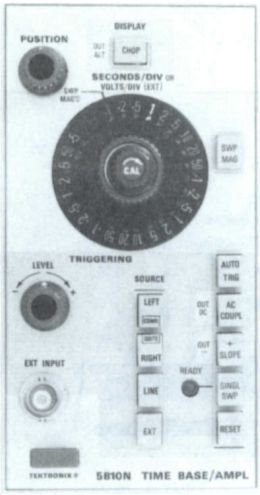
CHARACTERISTICS

Number of Differential Channels—Two.
Bandwidth—DC Coupled: DC to at least 1 MHz. AC Coupled: 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.
Deflection Factor—Calibrated: 50 μV to 5 V/div in 16 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.
CRT Readout—CRT readout of deflection factors. Functional in CRT readout-equipped 5400-Series oscilloscopes, nonfunctional in 5100-Series oscilloscopes.
Input R and C—1 MΩ within 0.15% paralleled by ≈47 pF.

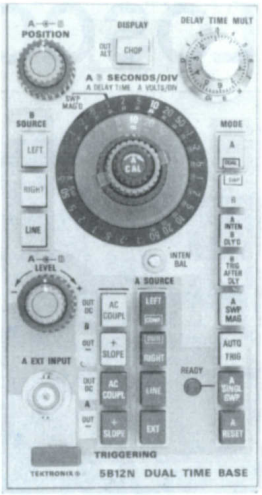
Maximum Input Voltage

	DC Coupled	AC Coupled
50 μV to 50 mV/div	10 V (dc+ peak ac)	10 V ac, 350 V (coupling cap precharged)
100 mV to 5 V/div	350 V (dc+ peak ac)	350 V (dc+ peak ac)

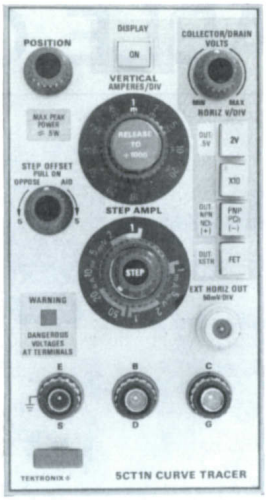
Maximum Input Gate Current—100 pA or less (equivalent to 100 μV or less, depending on external loading) at +25°C.
Displayed Noise—30 μV or less, tangentially measured.



5B10N Dual-Sweep Time Base



5B12N Time Base/Amplifier



5CT1N Curve Tracer

Common-Mode Rejection Ratio	
DC Coupled	
50 μV to 50 mV/div	At least 100,000:1 from DC to 30 kHz with up to 20 V p-p sine wave
100 mV to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sine wave
AC Coupled	
50 μV to 50 mV/div	At least 20,000:1 at 5 to 30 kHz, decreasing to not less than 2000:1 at 60 Hz

ORDERING INFORMATION

5A26 Dual Differential Amplifier **$1,390**
Includes: Instruction manual (070-1947-00).
P6055 High CMRR Differential Probes Matched pair for maximum CMRR performance. See Accessories section. **$540**

For recommended probes, see 5000-Series Reference section and Accessories section.

5B10N/5B12N

- **100 ns to 5 s/Div Calibrated Time Base**
- **Single-Sweep Operation**
- **X10 Magnifier**
- **Alternate and Chopped Displays**
- **50 and 500 mV/Div External Input**
- **Dual and Delayed Sweep (5B12N)**

The 5B10N and the 5B12N time-base units are designed for use with the Tektronix 5100-Series oscilloscope mainframes. They can also be used with the Tektronix 5400-Series mainframes, although they do not activate the scale-factor readout in the 5400 Series.

The 5B12N is a dual time-base unit that provides both delayed and dual sweeps.

An external signal-input connector on both the 5B10N and the 5B12N allows their use as a conventional amplifier to provide X-Y operation of the oscilloscope without the need for switching plug-in units.

CHARACTERISTICS

The following specifications are the same for the 5B10N and the A sweep of the 5B12N. B sweep specifications are identical except where indicated.

MAIN SWEEP

Sweep Rates—Calibrated: 1 μs to 5 s/div in 21 steps (1-2-5 sequence). X10 Magnifier extends displayed sweep time/div to 100 ns. Uncalibrated: Continuously variable between steps and to 12.5 s/div. B Sweep: 0.2 μs to 0.5 s/div in 20 calibrated steps.
Sweep Accuracy—Unmagnified: Within 3% from 1 μs to 1 s/div and within 4% at 2 and 5 s/div. Add 1% for magnified sweep operation. B Sweep: Within 3% from 1 μs to 0.1 s/div. Within 4% at 0.2 μs, 0.5 μs, 0.2 s, and 0.5 s/div.

TRIGGERING

Triggering Sensitivity

	Coupling	To 1 MHz	At 2 MHz
DC	Internal	0.4 div	0.6 div
	External (A sweep only)	200 mV	200 mV
AC	Requirements increase below 50 Hz		

Auto Trig—Same as above except signal-rate requirements are 15 Hz and above.
Single Sweep—Same as for ac and dc coupled (A sweep only).
External Trigger Input—Maximum Input: 350 V (dc +peak ac). Input R and C: 1 MΩ within 2% paralleled by ≈70 pF. Trigger-Level Voltage Range: +5 to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor— Calibrated: 50 and 500 mV/div. Accuracy is within 3%. X10 variable extends range to at least 5 V/div.
Bandwidth—DC Coupled: DC to at least 1 MHz. AC Coupled: 2 Hz or less to at least 1 MHz.
Input R and C—1 MΩ within 2% paralleled by ≈70 pF.
Maximum Input Voltage—350 V (dc +peak ac).

DELAYING SWEEP (5B12N)

Delay Time—Accuracy: 1 μs to 0.5 s/div, within 1%. 1 to 5 s/div, within 2%. Multiplier range: 0.2 to 10.2 times the time/division setting. Multiplier Incremental Linearity: Within 0.2%.
Differential Time Measurement Accuracy—Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 to 5 s delay times.
Jitter—<0.05% of the time represented by one division of the delaying sweep selected.

ORDERING INFORMATION

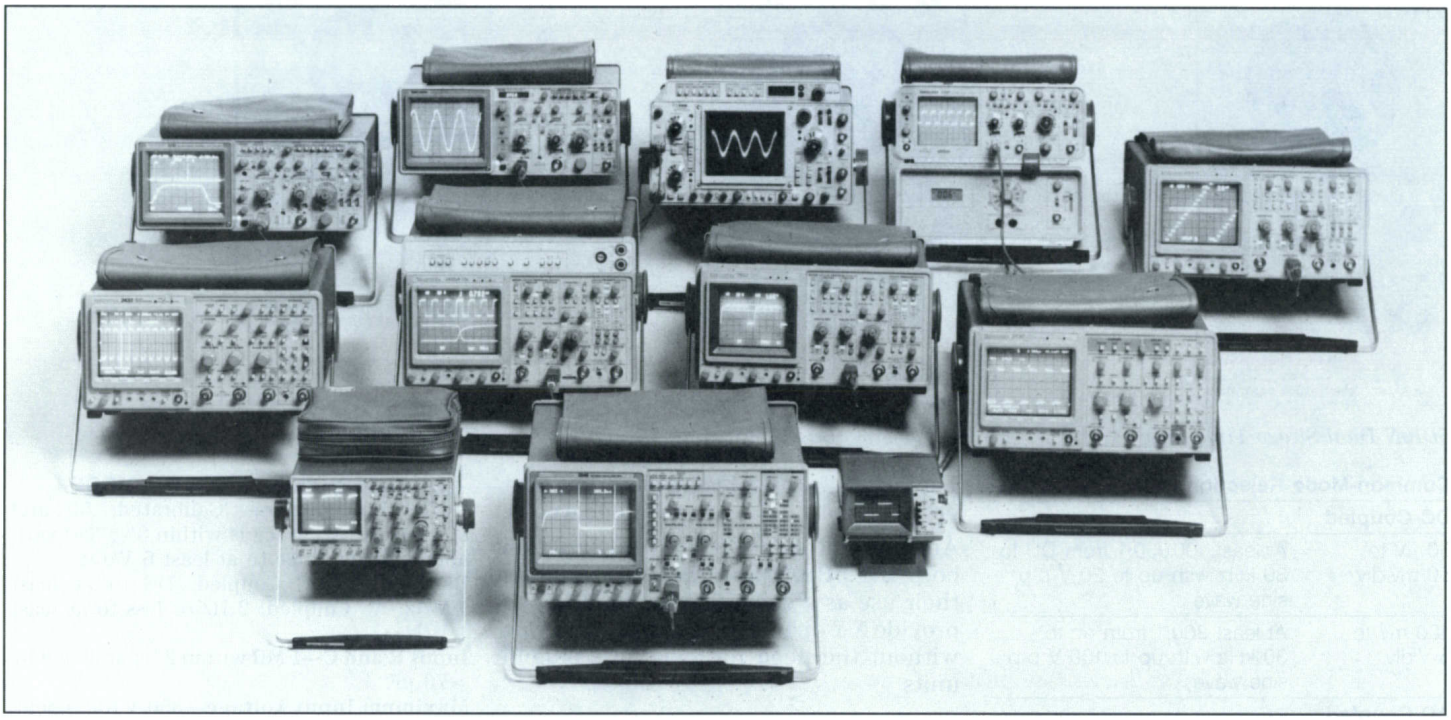
5B10N Time Base/Amplifier **$640**
Includes: Instruction manual (070-1140-00).
5B12N Dual-Sweep Time Base **$1,355**
Includes: Instruction manual (070-1141-00).

5CT1N Curve Tracer

- **Test Semiconductor Devices to 0.5 W**
- **10 nA to 20 mA/Div Vertical Deflection Factors**

See Curve Tracer section for complete description.

PORTABLE OSCILLOSCOPES



Tektronix offers the widest selection of portable scopes so you'll be able to choose the specific instrument that best suits your needs.
28 portable scopes with many optional features are available with bandwidths from 500 kHz to 350 MHz.

All Portable Oscilloscopes listed in this section are available through the National Marketing Center by calling toll free 1-800-426-2200 ext. 99. In addition to being able to give you direct order entry, the NMC Sales Engineers are available to offer you immediate technical assistance about product specifications, capabilities, and applications. They can send you literature, discuss available accessories, tell you about payment terms and options, or help you contact you local sales and service office.

CONTENTS

Portable Scopes
Selection Guide 301
Portable Scopes
Application Notes 302
Portable Scopes
Accessories Chart 302

Portable Nonstorage Oscilloscopes
2467 350-MHz, Four-Channel High Visual Writing Speed 303
2465A 350-MHz, Four Channel . . 303
2445A 150-MHz, Four Channel . . . 303
2465A DV Special Edition 350 MHz 305
2465A DM Special Edition 350 MHz 305
2465A CT Special Edition 350 MHz 305
2455A 250-MHz, Four Channel . . 303
2335 100-MHz, Dual Trace 316
2336 100-MHz, Dual Trace with ΔTime 316
2336YA 100 MHz, Dual Trace with ΔTime, Elapsed Time Meter 316
2337 100-MHz, Dual Trace with ΔTime & DMM 316
2236 100-MHz, Dual-Trace, Dual Time Base, with Counter, Timer, Multimeter 320
2235 100-MHz, Dual-Trace, Dual Time Base 320
2245 100-MHz, Four-Channel, CRT Readout 326
2246 100-MHz, V meter, Cursor, CRT Readout, ΔTime, 4 Channel 326
2225 50-MHz Dual-Trace, Alt Mag 329

Tektronix Classroom Series 334
Educational Materials 338

305 Battery Powered
5 MHz/DMM 341
221 5 MHz 342
213 1 MHz/DMM 343
212 500 kHz Dual Trace 345

Portable Storage Oscilloscopes
466 100 MHz Dual Trace, Dual Time Base 347
314 10 MHz Dual Trace 350
214 500 kHz Dual Trace 351

Portable Digital Storage Oscilloscopes
2430A/2430M 150-MHz Digital Storage 346
2220 60-MHz Digital Storage 346
2221 60-MHz Digital Storage 364
2230 100-MHz Digital Storage . 346
336 50-MHz Digital Storage 368

Portable Power Accessories
1105 Power Supply 332
1106 Battery Pack 332
1107 DC Inverter 333
A6901 Ground Isolation Monitor . 527
A6902B Voltage Isolator 528

PORTABLE REAL TIME OSCILLOSCOPE SELECTION GUIDE

Product	Bandwidth (MHz)	Sensitivity (mV/div)	Number of Channels	Delayed Sweep	Fastest Sweep (ns/div)	Features	Size mm (in.) H×W×D	Weight kg (lb)	Power Requirements	Prices Begin at
2467	350	2	4	✓	500 ps	4 div/ns visual writing speed, CRT readout, ΔVolts, ΔTime cursors	190×330×467 (7.5×13×18.4)	10.9 (24)	Line (90-132/180-250 V ac, 48-440 Hz)	$11,900
2465A*1 **2465A CT*2** **2465A DM*2** **2465A DV*2**	350	2	4	✓	500 ps	CRT Readout, ΔVolts, ΔTime Cursors	190×338×434 (7.5×13.3×17.1)	10.2 (22.4)	Line (90-132/180-250 V ac, 48-440 Hz)	$5,550 $7,150 $8,400 $9,200
2455A*1	250	2	4	✓	1	CRT Readout, ΔVolts, ΔTime Cursors	190×338×434 (7.5×13.3×17.1)	10.2 (22.4)	Line (90-132/180-250 V ac, 48-440 Hz)	$5,350
2445A*1	150	2	4	✓	1	CRT Readout, ΔVolts, ΔTime Cursors	190×338×434 (7.5×13.3×17.1)	10.2 (22.4)	Line (90-132/180-250 V ac, 48-440 Hz)	$3,590
2335	100	5	2	✓	5	Rugged, compact, lightweight	140×270×430 (5×11×17)	7.7 (17)	Line (100-132/200-250 V ac, 48-440 Hz)	$3,940
2336	100	5	2	✓	5	B Trigger, ΔTime	(140×270×430) (5×11×17)	7.7 (17)	Line (100-132/200-250 V ac, 48-440 Hz)	$4,270
2336YA	100	5	2	✓	5	B Trigger, ΔTime, elapsed time indicator, extra probes and manual	(140×270×430) (5×11×17)	7.7 (16.5)	Line (100-132/200-250 V ac, 48-440 Hz)	$4,490
2337	100	5	2	✓	5	B Trigger, ΔTime, DMM	140×270×430 (5×11×17)	7.7 (17)	Line (100-132/100-250 V ac, 48-440 Hz)	$4,700
2245	100	2	4	✓	2	Full triggering features for both A and B sweeps. CRT Readout of scale factors and delay time.	176×360×445 (7×14.2×17.5)	7.5 (16.5)	Line (90-250 V ac, 48-440 Hz)	$1,775
2246	100	2	4	✓	2	Full triggering features for both A and B sweeps. CRT Readout of scale factors and delay time. Time/Volts cursors and Δtime function. Voltmeter functions with smart cursors.	176×360×445 (7×14.2×17.5)	7.5 (16.5)	Line (90-250 V ac, 48-440 Hz)	$2,400
2246 Opt 01	100	2	4	✓	2	Full triggering features for both A and B sweeps. CRT Readout of scale factors and delay time. Time/Volts cursors and ΔTime function. Voltmeter functions with Smart Cursors. Meets MIL SPEC 28800C Type III, Class 3.	176×360×445 (7×14.2×17.5)	7.5 (16.5)	Line (90-250 V ac, 48-440 Hz)	*5
2235	100*3	2	2	✓	5	Dual Time Base, Single Sweep Trigger View, BW Limit	137×360×440 (5.4×14.2×17.3)	6.1 (13.5)	Line (90-250 V ac, 48-440 Hz)	$1,575
2235 Opt 01	100*3	2	2	✓	5	Dual Time Base, Single Sweep Trigger View, BW Limit, Scale Illumination, HF/LF Rej Meets MIL SPEC 28800C Type III, Class 3	137×360×440 (5.4×14.2×17.3)	6.1 (13.5)	Line (90-250 V ac, 48-440 Hz)	$2,195
2236	100*3	2	2	✓	5	Dual time base with 100 MHz counter, timer, and full-function voltmeter	137×360×440 (5.4×14.2×17.3)	7.4 (16.3)	Line (90-250 V ac, 48-440 Hz)	$2,795
2225	50	0.5 5 @ 50 MHz	2		5	Alternate magnification, p-p auto X10 vert mag, HF/LF rej single sweep, TV trigger	138×380×438 (5.4×15.0×17.2)	6.6 (14.6)	Line (95-128/185-250 V ac 48-440 Hz)	$995
305	5	5	2		100	Autoranging DMM battery power	110×240×370 (4.4×9×15)	4.8 (10.6)	Built-in battery, line (90-132/180-264 V ac, 48-440 Hz), or external dc	$3,060
221	5	5			100	5 MHz hand-held	80×130×230 (3×5×9)	1.6 (3.5)	Built-in battery, line (90-250 V ac, 48-62 Hz)	$2,715
213	1	20			400	DMM/scope at <4 lb (1.7 kg)	70×130×230 (3×5×9)	1.7 (3.7)	Built-in battery, line (90-136/180-250 V ac, 48-62 Hz), or external dc	$3,300
212	0.5 (500 kHz)	10	2		1000 (1 μs/div)	Integral 1 MΩ probe	80×130×240 (3×5×10)	1.6 (3.5)	Built-in battery, line (104-126 V ac, 58-62 Hz)	$2,095

PORTABLE STORAGE OSCILLOSCOPE SELECTION GUIDE

Product	Bandwidth (MHz)	Sensitivity (mV/div)	Dual Trace	Delayed Sweep	Fastest Sweep (ns/div)	Features	Size mm (in.) H×W×D	Weight kg (lb)	Power Requirements	Prices Begin at
2430A	150	2	✓	✓	5	Digital Storage, 100 MS/s with 8-bit resolution and dual-channel acquisition	190×330×479 (7.5×13×18.8)	11.1 (24.4)	Line (90-132/180-250 V ac, 48-440 Hz)	$8,900
2230	100	2	✓	✓	5	Digital Storage 20 MS/s at 5μs/div and faster	137×237×440 (5.4×9.3×17.3)	8.3 (18.0)	Line (90-250 V ac, 48-440 Hz)	$4,995
466	100	5	✓	✓	5	Fast transfer and variable persistence. 3,000 div/μs stored writing speed at reduced scan	160×330×550 (6×13×22)	11.8 (26)	Line (99-132/198-264 V ac, 48-440 Hz) or battery pack	$8,590
2220	60	2	✓		5	Digital Storage 20 MS/s at 5μs/div and faster	137×237×440 (5.4×9.3×17.3)	8.3 (18.0)	Line (90-250 V ac, 48-440 Hz)	$2,995
2221										$3,995
336	50	5	✓	✓	100	Digital Storage 1 MS/s Microprocessor control and menu driven*4	112×237×482 (4.4×9.3×14.6)	5.1 (11.3)	Line (90-132/180-250 V ac, 48-440 Hz)	$5,470
314	10	1	✓		100	Bistable, Stored viewing time to 4 hr 400 div/ms stored writing speed	110×240×350 (4.4×9×14)	4.7 (10.3)	Line (90-132/180-264 V ac, 48-440 Hz) or external dc	$4,935
214	0.5 (500 kHz)	10	✓		1000 (1 μs/div)	Bistable, 500 div/μs stored writing speed. Fully self-contained	80×130×240 (3×5×10)	1.6 (3.5)	Built-in battery, line (104-126 V ac, 58-62 Hz)	$2,865

*1 *The 2467, 2445A, 2455A and 2465A offer as options: 4½ digit DMM, 150 MHz Counter/Timer/Trigger, 17-Bit Word Recognizer, TV Trigger and GPIB Interface.*
*2 *Special Edition 2465A.*
*3 *The 2235 and 2236 are specified 100 MHz for sensitivities from 5 mV to 5 V/div and 90 MHz in 2 mV.*
*4 *See specifications in Digitizer section.*
*5 *Contact your local sales office for information.*

PORTABLE SCOPE PRODUCT LITERATURE AND APPLICATION NOTES

Tektronix product literature is readily available from your local Tektronix Sales Office.

For data sheets and product brochures, just ask for literature on the specific instrument. Additional related publications also available are listed below.

Title	Description	Order
Portable Oscilloscope Selection Guide	A helpful aid for choosing the right portable scope for your needs.	38-W-5158-2
2000 Series Warranty Brochure	Describes Tek's 3-year warranty on 2000 Series scopes and 5-year *Warranty-Plus* Service	81-W-5258
Using the 2336	Pocket Reference Guide	46-W-5732
2245/65, 2445/65 TDR	Application Note	38-W-5221-1
Quick and Easy Phase Measurement	Application Note	38-W-5223-1
Chip CRT and Assembly	Article Reprint	38-W-5312
400 Series Portable CRT Storage Scopes	Describes the 466, 464, and 434 portable storage scopes	40-W-3793-2
336 Brochure	Describes 336	53-W-5426-1
XYZs of Using a Scope	A basic primer that features the 2225 Series	46-W-6428
XYZs Instructor's Aid	Supplement to Primer	46-W-5169-2
XYZs Workbook	Supplement to Primer	46-W-5170-2
Using Delayed Sweep In Measuring Digital Word Trains	Application Note (2246)	41-AX-3349
VITS Analysis for TV Servicing	Application Note	41-AX-4047-1 46-W-5207
Basic Video System Measurements	Describes TV measurements using 2445A/65A Option 05 scopes	38-W-5511
Pulse Parameters	Application Note (2236)	46-W5205-1
Frequency Measurements	Application Note (2236)	46-W-5206-1
Pulse Ringing and Overshoot	Application Note (2236)	46-W-5209
Swept Frequency Filter and Amplifier	Application Note (2236)	46-W-5210
Power Supply Testing	Application Note (2236)	46-W-5211
General Troubleshooting	Application Note (2236)	46-W-5212
TDR Measurements with a scope	Application Note (2236)	46-W-5215 46-W-5216
Pulse rise Time	Application Note (2236)	46-W-5217-1
Integrating a Scope	Article Reprint	46-W-5337
Portable Storage	Selection Guide	41-W-5546
Your Direct Line to the World's Best Instruments and Technical Expertise	Find out about the Tektronix National Marketing Center and Tek's Service Offices	60-A-4873-1
2245/2246 VITS Analysis for TV Servicing	Application Note	46-W-6311
2225: Setup and Analysis	Technique Brief	46-W-6425
Rise Time	Technique Brief	46-W-6427
Dual Trace & X-Y Phase	Technique Brief	46-W-6424
Amplitude	Technique Brief	46-W-6426
Period and Frequency	Technique Brief	46-W-6423
2225 Primer	Concepts	46-W-6428

Title	Description	Order
2225 Instructor's Aid	Supplement to Primer	46-W-6466
2225 Workbook	Supplement to Primer	46-W-6465
2225 Poster	Supplement to Primer	46-W-6430
2215A Primer	Concepts	46-AX-4758-2
2215A Poster	Supplement to Primer	46-TT-528
ABCs of Probes	Primer on signal acquisition probes, applications, specs and selections	60-W-6053
DSO Primer	Concepts	41-W-6051
Waveform Storage using the 2230	Concepts	41-W-6392
Peak Detect Feature of the 2230	Concepts	41-W-6393
Capture of Transient Events with the 2230	Concepts	41-W-6398
Signal Averaging Using the 2230	Concepts	41-W-6570
Scan & Roll Modes for Capturing Slow Events	Concepts	41-W-6570
Single Fiber Muscle Research Using the 2230	Application Note	41-W-6395
2230 Data Acquisition for Process Control	Application Note	41-W-6024
Muscle Fatigue Research Using the 2230	Application Note	41-W-6396
Computer Disk Drive Repair with the 2230	Application Note	41-W-6397
Using the 2230 to Design Zero Defects into the Manufacturing Process	Application Note	41-W-6504
G.E. Medical Diagnostic Instrument Service	Application Note	41-W-6571
DSOs: Take a New Look	Article Report	41-W-6484
New DSO Techniques for Capturing Elusive Glitches	Article Reprint	41-W-6480
Use a DSO to get More and Better Data	Article Reprint	37-W-6251
GPIB Utility Software for 4041	Software Data Sheet	41-W-6486
GPIB Waveform Analysis Software for 4041	Software Data Sheet	41-W-6496
GPIB Utility Software for the IBM PC	Software Data Sheet	41-W-6485
RS-232C Utility Software for IBM PC	Software Data Sheet	41-W-6503
Think-Jet Printer	System Applications	41-W-6497
EPSON Printer	System Applications	41-W-6499
HP-GL Plotter	System Applications	41-W-6501
X-Y Plotter	System Applications	41-W-6489
2220/2221/2230	Brochure	41-A-6656
2220/2221/2230	Data Sheet	41-W-6657

PORTABLE SCOPE/ACCESSORIES COMPATIBILITY GUIDE

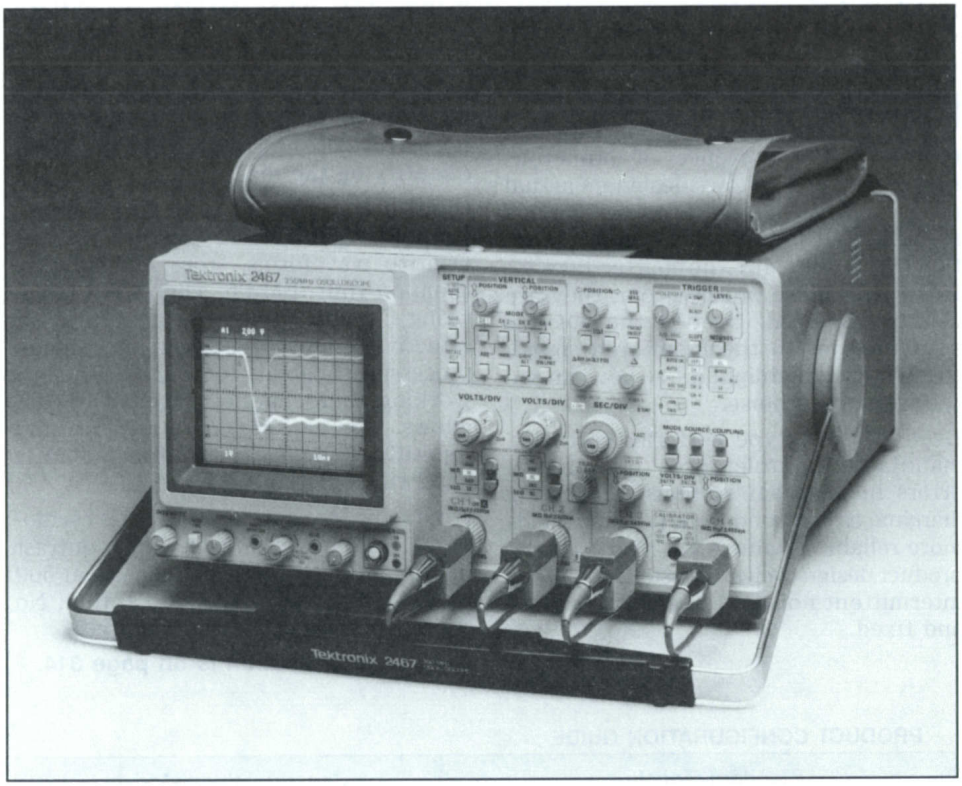
	PROBES*5			CAMERAS			CARTS	MISCELLANEOUS ACCESSORIES
	Passive	**Active**	**Current**	**Single Shot or Low Rep Rate**	**Stored/Stable or Repetitive**	**Low Cost**		
2430A **2445A** **2455A** **2465A** **2465A DV** **2465A CT** **2465A DM** **2467**	P6101A, P6009 P6015, **P6133** **(2445A, 2430A)** **P6136** **(2467/65A/55A)**	P6201 P6202A P6230	P6021/P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adapter*1	C-30B Opt 01 016-0269-03 adapter*1	C-5C Opt 02 016-0359-01 adapter*1 C-4 122-0894-01	K212	Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; 1105 Power Supply; 1106 Battery Pack; 1107 Dc Inverter Power Supply; Protective Cover 016-0720-00.
2335 **2336** **2336YA** **2337**	P6130 P6009 P6063B P6015 **P6108A** P6101A (2236YA)	P6202A P6201 P6230	P6022 A6302/AM 503 A6303/AM 503 P6021	NA	NA	C-5C Opt 04 016-0359-01 adapter*1 (with flash) C7 Opt 2 016-0359-01 adapter*1	K212	2335 Rack Adapter Kit 016-0468-00.
2245 **2246** **2220** **2230** **2235** **2236** **2225**	P6101A P6009 P6130 P6015 P6062B P6230 **P6122** **P6121 (2236, 2230)** P6109 (2245, 2246) P6103 (2225)	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adapter*4	C-31B Opt 01 016-0269-03 adapter*4	C-5C Opt 04 016-0359-01 adapter*1*3 (with flash) C-4 Option 02*4 C-7 Opt 02*4, Opt 03*4 C-5C Opt 02*4	K212	Clear CRT Light Filter 337-2775-01; CRT TV Graticule Custom Mod; Accessories Pouch 016-0677-02; Front Cover 200-2520-00; RM Kit: 016-0466-00 for 2235; 016-0819-00 for 2225; 016-0833-00 for 2235 Opt 01; 016-0015-00 for 2236; RM Kit: F2240R for 2245/2246; P6602 Temperature Probe
466	P6101A P6015 **P6105A** P6009 **P6062B** P6130	P6201 P6202A P6230	P6022 A6302/AM 503 A6303/AM 503 P6021	C-31B Opt 01 016-0269-03 adapter*1	C-30B Opt 01 016-0269-03 adapter*2	C-5C Opt 02 016-0359-01 adapter*1 C-4 122-0894-01 adapter*1 C-7 Opt 2 016-0359-01 adaptor *1	K212	Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; Protective Cover 016-0365-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adapter 016-0675-00.
314, 305 **336**	P6101A **P6149A** **P6148A (336)**		P6021, P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0327-01 adapter*2	C-30B Opt 01 016-0327-01 adapter*2		NA	Viewing Hood 016-0297-00; Mesh Filter 378-0063-00; 1105 Battery Power Supply; Rain Cover (314, 335) 016-0612-00.

*1 *Mounting adapter comes with camera/option listed, others are optional.*
*2 *Mounting adapter must be ordered in addition to the camera/option listed.*
*3 *2235 Opt 01 Order C-5C Opt 02 or C7 Opt 03.*
*4 *Camera listings recommended for 2235 Opt. 01, 2245, and 2246.*
*5 *Highlighted probes are preferred for typical general purpose use and/or are shipped as included accessory to the instrument.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

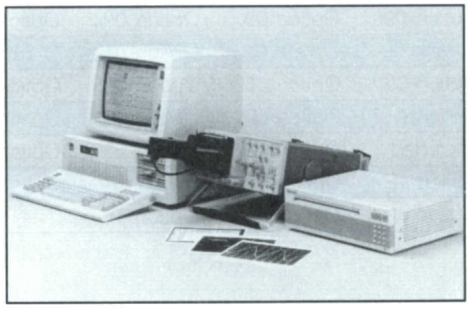
The Standard of Excellence in Portable Oscilloscopes

See, measure, automate at the touch of a button



2467/2465A/2445A

- 350-MHz Bandwidth (2467, 2465A)
- 1-ns Rise Time (2467, 2465A)
- Auto Setup
- Save and Recall Setups
- Set-Up Sequencing
- On-Screen Trigger-Level Readout
- Volts and Time Cursors With On-Screen Readout
- Cursors After Delay
- 500-MHz Trigger Bandwidth (2467, 2465A)
- Four Independent Channels 500 ps/Div Time Base (2467, 2465A)
- Switchable 1 MΩ and 50 Ω Inputs
- 20-ps Time-Interval Resolution
- 2 mV/Div Vertical Sensitivity at 350 MHz
- On-Screen Scale-Factor Readout
- Lightweight and Rugged



DCS01/2467 Digitizing Camera System captures repetitive waveforms and transients from analog scopes according to a scope's CRT visual writing speed (2467: 4 div/ns).

2467

GPIB IEEE-488 The 2467 Option 10 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **4 ns/Div Visual Writing Speed**

Observe faults you couldn't see before. From single-shot, low rep-rate pulses to occasional glitches and fast transients to metastability and jitter in high-repetition rate signals, the Tektronix 2467 instantly reveals events that cannot be displayed or measured by any other portable scope. You now can see high-speed, single-shot phenomena and low-repetition rate analog and digital signals as they occur, at sweep speeds to 500 ps/div without a viewing hood.

At the heart of the 2467's extraordinary capabilities is Tektronix' microchannel-plate (MCP) CRT.
The unique property of an MCP display amplifies the intensity of infrequent signals, yet limits the intensity of signals with high repetition rates. Now see glitches that remain hidden on scopes with conventional CRTs, or are never captured on digital storage scopes because of low trigger probability.

CRT writing speed and intensity superiority results in an instrument able to display everything that happens in your circuit, whether it occurs once or repetitively. The technology that was pioneered by the 1-GHz Tektronix 7104 plug-in oscilloscope is available for a new range of applications in this portable, 350-MHz instrument.

With the 2467 you benefit from the dramatic increase in visual writing speed (VWS) compared to the fastest conventional CRT. The 2467 VWS is 4 div/ns versus 0.04 div/ns for the conventional CRT used in the 2465A. Just being able to see unexpected transients, even when masked by highly repetitive events, makes the critical difference in many design and troubleshooting situations.

Make single-shot and low-repetition-rate measurements.
Even at 500-ps/div sweep speed, the 2467's 4-div/ns visual writing speed displays the lowest repetition-rate signals, even single shots, in normal room light. Its 350-MHz bandwidth faithfully reproduces your signal's high-frequency details.

Using the trigger-level readout feature, you can set the proper trigger point for your experiment the first time—no more guessing where the trigger point is set. And there's no wasted time and materials repeating the experiment just to properly set the trigger level.

Excellent EMI protection means reliable operation even in the high fields generated by high-power lasers, ESD testing, or NMR equipment.

Find circuit problems in digital systems.
When troubleshooting a digital system, you want to see a fault immediately. In digital circuits, violations of either timing or noise margins can result in faulty operations, such as low-amplitude (runt) pulses, slivers, or metastability. If the margin violations are infrequent, faulty outputs are even less frequent.

A real-time oscilloscope with an MCP-enhanced CRT, such as the Tektronix 2467, can display intermittent variations as they happen, making them instantly visible, even though they may be masked by thousands of normal traces. Other instruments either cannot display infrequent faults at all or they may take several minutes to build up a display that shows an occasional fault.

With 30-ns pretrigger display, you can examine the inputs to a logic device prior to the output transition. Seeing the inputs when a fault occurs can point to the real problem.

Determine actual noise margins.
With its ability to clearly display transient events in the presence of numerous signals, the 2467 shows designers actual noise margins. Adequate noise margins are essential for reliable system operation. With the 2467, no matter how infrequently noise pulses occur, they are clearly displayed. Even if the noise is asynchronous to the monitored signal, the 2467 will highlight it—so you can see the worst-case noise.

Even if a prototype performs correctly, manufacturing tolerances can induce errors in marginal systems. Correcting marginal circuit conditions not only yields more reliable products but also shortens product design cycles. Crosstalk and other intermittent noises are easily identified and fixed.

Measure random noise and jitter in communication systems.
Eye patterns are often used as a performance measure in a digital communication channel. The use of eye patterns is enhanced by the 2467's high visual writing speed, which permits viewing the worst-case effects of random or erratic noise, jitter and other channel impairments. Also when making eye-pattern measurements, cursors can be applied in either the voltage-ratio or time-ratio mode. Employed in this way, they indicate degradation as a percentage of the normal eye opening, thus simplifying and quantifying the measurement.

Digitize and capture even single-shot events to 350-MHz bandwidth.
Digitize waveforms, store and analyze them on your IBM PC. The DCS01 (Digitizing Camera System) easily and cost-effectively adds digitizing and signal-processing capability to the 2467. The fast working microchannel plate (MCP) CRT allows the capture of transient and repetitive signals at the full 350-MHz bandwidth of the 2467.

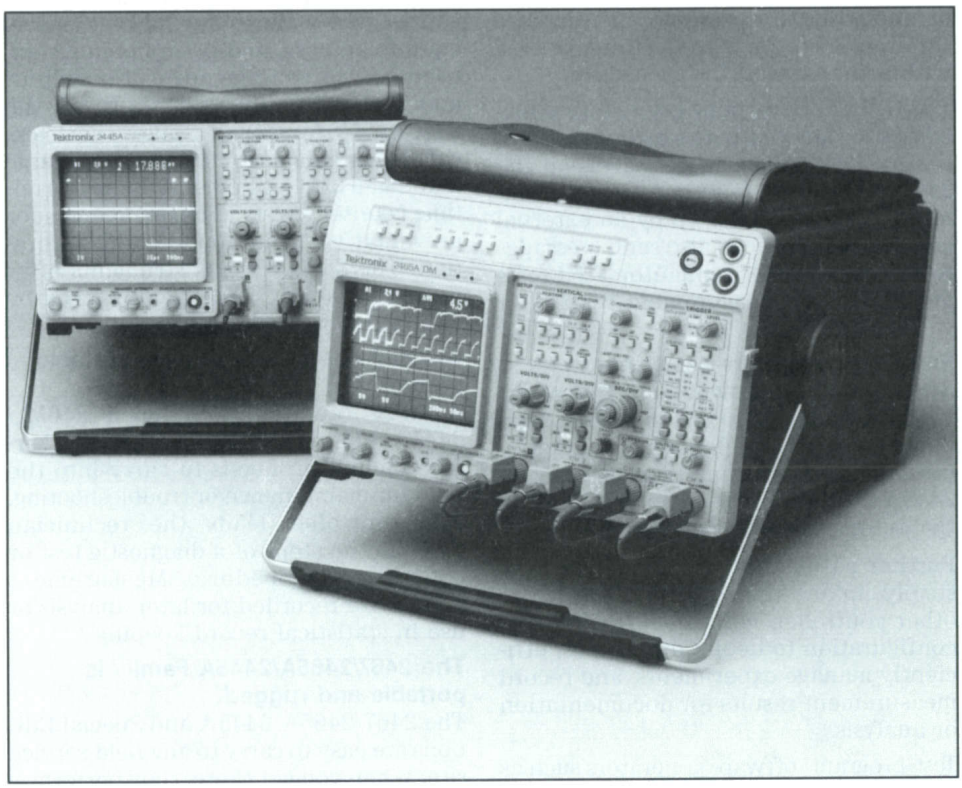
For documentation, a C-30 Series oscilloscope camera produces high-contrast photographs of single-shot signals at 500 ps/div using common ISO 3000 film. No special camera or film is required.

Ordering information is on page 314.

PRODUCT CONFIGURATION GUIDE

Configuration	Standard Models				Special Edition Models		
	2467	2465A	2455A	2445A	2465A CT	2465A DM	2465A DV
Bandwidth	350 MHz	350 MHz	250 MHz	150 MHz	350 MHz	350 MHz	350 MHz
GPIB	Option 10	Option 10	Option 10	Option 10	Included	Included	Included
Counter/Timer/Trigger, Word Recognizer	Option 09	Option 09	Option 09	Option 09	Included	Included	Included
DMM		Option 01	Option 01	Option 01		Included	Included
Video Measurement System	Option 05	Option 05	Option 05	Option 05			Included
Counter/Timer/Trigger, No Word Recognizer	Option 06	Option 06	Option 06	Option 06			
Two Additional Probes	Included	Option 22	Option 22	Option 22	Included	Included	Included
Rackmount	Option 1R	Option 1R	Option 1R	Option 1R	Option 1R		
Probe Power	Option 11	Option 11	Option 11				

See, Measure, Automate at the Touch of a Button



2465A/2445A/ 2465A CT/2465A DM/ 2465A DV/2467

Special Editions

GPIB IEEE-488 The 2465A/2445A Option 10, 2465A CT, 2465A DM and 2465A DV comply with IEEE Standard 488-1987 and with Tektronix *Standard Codes and Formats.*

The Tek 2467/2465A/2445A family: high-performance capabilities to match your tough assignments.
Start with the standard-setting performance of Tek's top portable analog scopes. Add productivity-enhancing features for fast operation. Provides a probe-tip bandwidth to 350 MHz. The result: six four-channel, dual time-base oscilloscopes that bring unprecedented efficiency to your design lab, production line or field-service site.

Auto setup, instant recall, and set-up sequencing for easy answers fast!
So easy to use that now you simply attach up to four probes to signal points, press Auto-Setup, and within seconds a stable, automatically-triggered display of the probed waveforms appears on screen for viewing or advanced parametric characterization. With Auto-Setup, users of any experience level will gain increased speed and ease of use in making day-to-day waveform observations and measurements.

Digital-design and test personnel are sure to appreciate Tek's proprietary Pulse Mode for viewing narrow pulses in detail. Auto-Setup calculates the duty factor and properly displays either the low-duty-cycle pulse or several cycles or symmetrical waveforms. Also, input channel selection is sensed, and display positioning adjusted for up to four waveforms with appropriate scaling.

Time and voltage cursors.
Use the cursors to obtain quick readouts of voltage, time, frequency, ratio, and phase with no interpretation or CRT linearity errors. Readouts are in units of volts, time, percent, and degrees. The cursors can even be applied to delayed sweep displays, improving timing measurement flexibility.

Tektronix' hybrid preamplifiers make possible a 350 MHz bandwidth—in the 2465A/2467, even at 2 mV/div sensitivity. New probes take the full bandwidth to the probe tip—where you need it.

Timing measurements are possible with 20-ps resolution at sweep speeds to 500 ps/div in the 2467/2465A and to 1 ns/div in the 2445A. Trigger on signals to at least 500 MHz with the 2467/2465A and to at least 250 MHz with the 2445A, which extends the usefulness of each scope well beyond its vertical bandwidth.

Trigger from any one of the four input channels or on four asynchronous signals. Tek's Auto-Level Trigger mode keeps your scope triggered even as the input signal changes. You can choose to trigger at the 10, 50, or 90% level of the signal. On-screen trigger-level readout eliminates trial-and-error triggering, saving you time and frustration.

CRT readout of the vertical scale factors, input coupling, sweep speeds, trigger level and source, and indicators such as Bandwidth Limit and Holdoff give you complete status information at a glance. These readouts are recorded on film in your waveform photos.

Dual, delaying time bases, each with independent trigger systems allow for precise measurements using one or both sweeps.

Tailor your 2467/2465A/2445A for special needs, or choose a specially configured measurement package.
To fit specialized performance requirements, the 2467/2465A/2445A Family offers six integral individual or combinable enhancements: GPIB Interface, Digital Multimeter, Counter/Timer functions with Enhanced Triggering, 17-bit Word Recognition, and Video-Measurement capabilities.

You can also select one of three 2465A Special Editions which, as packages, are preconfigured for a significant savings over separately ordered measurement options.

The 2465A CT is configured especially for use with communications, office and computer-related equipment. The 2465A DM adds a digital multimeter for applications in government/military electronics, avionics, and ATE stations. Finally, there's the fully optioned 2465A DV for even more extensive applications including the design, manufacture, and service of raster-scan devices and high-resolution video eqiupment. The 2465A DV is easily the most powerful portable available.

With instant access to complex setups measure signal parameters quickly.

For closer examination of your signals and for more specialized setups, such as delayed-sweep displays or applications using the extended-measurement options, front panel controls are still necessary. Now however, you need to create these setups only once. Nonvolatile memory for 30 setups stores *all* front-panel information, including cursor locations and control settings for the extended-measurement options.

The Save/Recall utility is a tremendous time-saver for designers, evaluators, and production-test operators—who need several setups for measurements at multiple test points in a circuit or system. Switching between measurements is fast; just two buttons for a complete setup. Operator attention is focused on answers, not on control adjustments.

Measurements are highly reliable as well as efficient. Vertical and horizontal accuracy are tightly specified for a wide range of environmental conditions. Pulse response is optimized for flatness and speed, so the waveform measured truly represents the signal. With the advanced-feature set, including waveform cursors, the 2467/2465A/2445A Family minimizes errors and maximizes your confidence in measurement results.

Automate repetitive measurement sequences without an external controller.

Now systematic verification procedures for engineering prototypes, final production test, or field service can easily be set, stored, and sequenced without a computer. Step through up to 30 stored test setups in the order you choose. Just press the Step button once for each sequence step. Or plug a foot switch into the rear-panel audio jack for hands-free operation.

As an additional aid, seven-character alphanumeric labels can be stored with each setup. The labels can be test titles or operator prompts for test-point connections. You can protect the saved setups and sequences by write-protecting the memory.

Built-in sequencing and screen-message capabilities are standard throughout the 2467/2465A/2445A Family. With a single, standalone portable oscilloscope, you can implement extensive automated or semi-automated procedures. This feature provides an excellent, price-competitive entry into automated testing. The 2467/2465A/2445A Family offers complete upward mobility from the 2445A through the 2467 and its options.

Add the GPIB option and take advantage of no-controller setup and sequence transfers. Create or modify stored setups on one scope, for example, then update the other scopes in a production test area with a simple transfer procedure.

The GPIB option opens even more possibilities for automating measurement procedures. All front-panel controls on the 2467/2465A/2445A scopes are programmable and can be set up by an external controller, which can also send messages to the operator for semiautomated tests and read back measurement results for storage and analysis.

Personal computers assist hardware development and evaluation taskwork.

For many single-step and multistep tests during product development, characterization, and evaluation, the 2467/2465A/2445A's internal sequencer provides all the automation you need.

Further automation is accomplished by simply linking the scope with a PC, or other controller, via the GPIB. Use this configuration to debug prototypes, efficiently manage experiments, and record measurement results for documentation or analysis.

Test-program software generators such as EZ-TEK 2400 PC are designed so that developing your procedures involves little more than setting the scope's front-panel controls and making selections from a screen menu. *You* don't need to write code.

Decrease a product's time to market by using the same scope/controller system and software throughout the development cycle. Tests that were designed during the engineering phase can be used for evaluation, then adapted for production. Consistency will be maintained in methods and results.

Use oscilloscopes that are ideal for production-test systems.

Configuring 2467/2465A/2445A oscilloscopes for semiautomated operation takes advantage of the strengths of both humans and computers. The controller can record measurement results, make arithmetic-based pass/fail decisions, set the scope for each step of the procedure, and write prompting messages on the CRT. The operator's time is used efficiently to adjust cursors to the signal, compare waveforms against references marked by the controller with the cursors, and decide whether the visual criteria for each test has been met.

Combining the DMM, Video Measurement and CTT options with a 2465A/2445A oscilloscope provides multi-instrument capabilities while reducing rack space, equipment cost, and programming complexity. The self-diagnostic capabilities and self-calibration functions of the 2465A/2445A scopes make them excellent candidates for installation in large and small test systems. A built-in run-time counter assists in record keeping for preventative maintenance and calibration. The 2400 Series instruments offer proven reliability and are all backed by Tek's three-year warranty.

You can use a powerful yet portable system.

A GPIB- and DMM-equipped 2465A/2445A, plus a PC controller are all a service technician needs to carry into the field for maintenance or troubleshooting. The controller leads the technician through the steps of a diagnostic test or calibration procedure. Measurement results are recorded for later analysis or use in statistical record keeping.

The 2467/2465A/2445A Family is portable and rugged.

The 2467/2465A/2445A and Special Editions are easy to carry to any field-service site. When you get there, they perform—even in extreme conditions. Environmental characteristics include a low EMI profile and rugged construction.

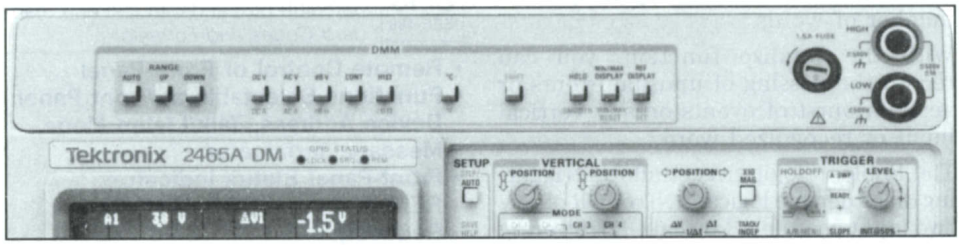
Channels 1 and 2 vertical input couplings can be independently selected as ac, dc, or ground. Or, terminate your circuit outputs and controlled-impedance transmission lines into 50 Ω. To protect against overload while using the internal 50 Ω terminations, the scopes automatically switch to 1 MΩ impedance when an overload is detected, and a readout indicates the change.

Assurance of error-free operation is backed by Tek's three-year instrument warranty.

This warranty includes the CRT and can be easily extended to five years (in most countries) through a variety of optional service plans.

This warranty policy plus Tek quality and proven reliability means you can expect outstanding value and long life from your oscilloscope investment. With new productivity-enhancing features to minimize training and operating time, the 2467/2465A/2445A Oscilloscope Family offers economical solutions to your needs in waveform observation, measurement, and automation; high performance at its affordable best.

Choose From a Complete Range of Options That Extend the Capabilities of the 2467, 2465A, 2455A, and 2445A



Option 01	Digital Multimeter
Option 05	Video Waveform Measurement System
Option 06	Counter/Timer/Trigger (CTT)
Option 09	CTT with Word Recognizer
Option 10	GPIB Interface
Option 1E	External Clock
Option 1R	Rackmounting

Digital Multimeter

Option 01

- **4½ Digit Autoranging Digital Multimeter**
- **True RMS AC Volts From 20 Hz to 100 kHz**
- **True RMS AC Current From 20 Hz to 10 kHz**
- **10 μV Resolution on DC Volts**
- **Continuity Beeper**
- **UL Listed, CSA Certified**
- **Temperature Probe −62 to +230°C**
- **Calibration via Front Panel Without Removing Instrument Covers**
- **Convenience Features Include: Set Reference, Hold, Smooth, Minimum/Maximum, dBV, and dBm**

The 2465A/2445A's Digital Multimeter (Option 01) makes it possible to measure dc and ac (RMS) volts and current, dBm, dBV, resistance, and temperature at your workbench with no added space requirements. Carry everything you need into the field for maintenance and repair, all in one rugged, portable package. The DMM and scope meet the same tough requirements for environmental conditions including temperature, humidity, and shock. Calibration of the DMM is accomplished from the front panel, without removing any covers. Plug a DMM-equipped 2465A/2445A into your system (rack-mounting is optional as a modified product) to take advantage of its fully-programmable measurements and screen prompts.

Blocks of accumulated measurements can be averaged and smoothed. Minimum and maximum values can also be displayed. Set a reference function if, for example, you need to compare deviations from a norm. Audible continuity checking is useful for applications in service, production, and design/development. Troubleshoot circuit board hot spots with the temperature probe, which registers temperature variations with 0.1 °C or °F resolution.

Combining the DMM and CTT options allows direct measurement of system frequency, period, or time interval while monitoring ac or dc volts, current, or temperature. use just one instrument to characterize voltage-to-frequency converters and temperature drift of crystal oscillators. Add the GPIB interface for a powerful measurement system to run tests and verification procedures and log measurement results with your controller.

Video Waveform Measurement System

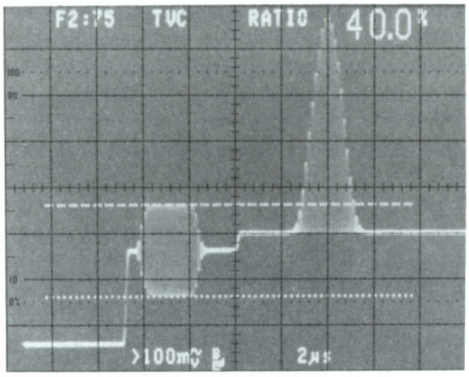
Option 05

- **Television Waveform Analysis Capabilities**
- **Selectable System-M and Nonsystem-M Protocols**
- **Selectable Triggering on Any Line Within a Field, With Line-Number Readout**
- **Compatible With Composite Video Having 13.1- to 77-kHz Line Rates**
- **TV Blanking-Level Clamp (Back-Porch)**
- **Optimized Vertical Response Comparable to High Performance TV Waveform Monitors**

Video measurement capabilities extend the 2467/2465A/2445A's power and versatility to meet the challenges in broadcast and cable television, graphics displays, and raster-scan systems. The Video Waveform Measurement System makes quality measurements convenient during every stage of a product's life cycle: design, production, system calibration, quality assurance, maintenance and service.

With CRT readout of the line number and field selected for triggering, an operator knows precisely what the display represents. Any line can be selected from Field 1, Field 2, or Field 1 alternating with Field 2. The fourth video trigger selection is Lines, which superimposes all the lines in both fields. Systems with up to 1280 lines can be accommodated.

The back-porch clamp locks the video black level to a fixed point, so the display is stable and clean, even when the composite video contains low-frequency hum or when the average picture level changes with ac coupling. Controls are provided for compatibility with a wide variety of system protocols.



This sample waveform and CRT readout show a 2445A's high-fidelity display and measurement of the color subcarrier amplitude on Line 75, Field 2 of an NTSC signal with the television blanking-level clamp (TVC) engaged. The cursor readout of 40% is interpreted as 40 IRE units with appropriate adjustment of the vertical gain.

Counter/Timer/Trigger (CTT)

Option 06

Option 06 provides the Counter/Timer/Trigger without the word recognizer probe. Specifications and included accessories are the same as Option 09. The word recognizer cannot be added to Option 06 after delivery of the oscilloscope (field retrofit kits are not available.)

Counter/Timer/ Trigger (CTT) with Word Recognizer (WR)

Option 09

- **Crystal-Controlled Time Base**
- **0.001% Accuracy**
- **Totalize Up to 9,999,999 Events**
- **Delay-by-Events Triggering up to 4,194,303 Events**
- **Boolean Logic Triggering on both Digital and Analog Signals**
- **17-Bit Word-Recognizer Probe**

Option 09 delivers the crystal-controlled timing accuracy and the extra triggering power you need for digital systems. Frequency and period are measured directly from any vertical channel. Time intervals can also be measured by the counter, with ease. The delayed sweep (B sweep) trigger has been expanded to select independent signal sources, slopes, and levels for the beginning and ending of a time interval. This expansion allows precise time measurements between two events, each with different characteristics (using the same or separate channels). This new capability provides for measurement of propagation delay (through a level shifter or an amplifier), as well as rise time, fall time, or processor power-up delay.

Once configured, these measurement setups can be saved in the scope's set-up memory, either to be recalled later or used as part of a sequence. With the CTT, recalled measurements are completely automatic and require no operator intervention.

With the Word Recognizer, any pattern of up to 17 digital bits can act as an input to the counter or as a trigger for the A or B sweep.

Pinpointing the "needle-in-a-haystack" signal in a digital system becomes feasible with the Word Recognizer and Delay-by-Events functions as these advanced triggering capabilities eliminate extraneous signals.

To characterize or "unravel" system , the CTT can measure the frequency or period of recognized words. Also, and it can delay the scope trigger by a selected number of words.

With the Totalize function, you can record the passing of unusual events or verify a burst of events on any vertical input or recognized word.

The Boolean-logic trigger allows triggering on either the logical AND or OR of any two input channels. Logical-OR triggering lets you trigger on either the positive or negative slope of any input signal. This function is known as "bislope triggering" and allows you to catch events reliably—even if you don't know whether the transition will be high-to-low or low-to-high.

The Counter/Timer/Trigger is also available without the Word Recognizer probe as Option 06.

External Clock

Option 1E

The External Frequency Reference option (Option 1E) provides the ability to make frequency measurements with eight-digit resolution. With an external reference signal attached to the rear-panel input connector, the CTT automatically detects the reference signal and makes all frequency measurements relative to the reference. Accuracy is equal to the external reference or one count in the Least Significant Digit of the eight-digit readout, whichever is greater.

Option 1E automatically accepts any one of the following frequencies as the external reference:

1.000000 MHz
3.579545 MHz (color burst frequency for video)
4.4336188 MHz
5.000000 MHz
10.000000 MHz

GPIB Interface

Option 10

GPIB IEEE-488 Bus Interface complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Remote Control of Front-Panel**
- **Functions Selectable at Front Panel: Device Address, Talk/Listen Mode, Message Terminator**
- **Front-Panel Status Indicators: REM (Remote), SRQ (Service Request), LOCK (Local Lockout)**
- **Compatible With All Other 2467/2465A/2445A Options**
- **User-Generated SRQ: To Signal Controller During Program Control**
- **RQS Control: Optional Enable or Disable of SRQ Reporting**

Network the 2467/2465A/2445A with your other equipment on the GPIB. Option 10 adds the ability to communicate over the IEEE-488 General Purpose Interface Bus. Contents of set-up memory can be transferred between 2467/2465A/2445A units without an external controller. Or use a host controller to assist the oscilloscope operator in performing a series of checks and measurements. Front-panel settings can be remotely set or changed, and the results of cursor, DMM, and CTT measurements communicated back over the bus to the controller, as well as appearing on the scope's CRT.

The ability to display prompting messages (by embedding them in control programs) reduces the chance of operator error at critical points in a test procedure.

The 2467/2465A/2445A GPIB-message structure conforms to Tektronix *Standard Codes and Formats*, ensuring that all GPIB messages are "human readable" and consistent in format. Selectable message termination characters allow scope use with most types of controllers. The new 2445A and 2465A are compatible with programs for their predecessors, the 2445 and 2465.

Tektronix software development packages provide an environment for quickly and easily generating automated and semi-automated test procedures. Not only are they easy for nonprogrammers to use, they substantially reduce the amount of time required to create a test-program using previous programming methods and languages.

TEK EZ-TEST and EZ-TEK 2400 are automatic test program generators designed for use with the Tek 4041 controller. EZ-TEK 2400 PC runs on the IBM PC, XT, and AT. The TEK EZ-TEST generator programs the 4041 to drive a wide variety of GPIB-compatible equipment. Both EZ-TEK 2400 and EZ-TEK 2400 PC are designed for systems that need only the capabilities found in 2467/2465A/2445A oscilloscopes and their options. None of these generators require previous GPIB programming experience since they use simple, multilevel menus to develop sophisticated test programs.

The Tek GPIB User's Resource Utility (GURU II) is a utility package for IBM PCs. It includes a GPIB interface board for the PC, GPIB cable, software and instruction manual.

Rackmounting

Option 1R

The 2467/2465A/2445A instruments are available in standard 19-inch rackmount configuration, complete with slide-out chassis tracks.

CHARACTERISTICS

Characteristics are common to the 2467, 2465A, 2455A, 2445A and 2465A Special Editions except where indicated.

VERTICAL SYSTEM

Display Modes—CH 1, CH 2, CH 3, CH 4, Add (CH 1+CH 2); Invert (CH 2 only); Alternating and Chopped display switching for all channels, and 20-MHz bandwidth limiting.

CHANNEL 1 AND CHANNEL 2

Deflection Factor—2 mV/div to 5 V/div in a 1-2-5 sequence of 11 steps.

Deflection Factor Basic Accuracy—±2% (measured at a volts/div setting with a four- or five-division signal, centered on screen)

ΔV Accuracy—±(1.25% of reading+0.03 div+signal aberrations). Basic accuracies apply for temperatures from +15 to +35°C. Add ±2% of reading for temperatures from −15 to +15°C and from +35 to +55°C. Add 1% of reading when 50 Ω input coupling is used. Add 1% of Channel 2 reading when inverted (measured with cursors anywhere on the graticule).

ΔV Range—±8 times the Volts/div switch setting.

Variable Range—Continuously variable between Volts/div switch settings. Extends deflection factor to at least 12.5 V/div.

Frequency Response (−3 dB Bandwidth)

Instrument	+15 to +35°C	−15 to +15°C +35 to +55°C
2467/2465A	350 MHz	300 MHz
2455A	250 MHz	200 MHz
2445A	150 MHz	150 MHz

All responses measured with standard accessory probe or internal 50 Ω termination.

AC Coupled Lower −3 dB Point—With 1X Probe: 10 Hz or less. With 10X Probe: 1 Hz or less.

Step Response—2467/2465A: ≤1 ns. 2455A: ≤1.4 ns. 2445A: ≤2.33 ns. (Rise times calculated from $t_r = 0.35/BW$.)

Common-Mode Rejection Ratio (Add Mode With CH 2 Inverted)—≥20:1 at 50 MHz for common-mode signals of 8 div or less, with Var Volts/div control adjusted for best CMRR at 50 kHz at any Volts/div setting ≥5 mV.

Channel Isolation—≥100:1 attenuation of deselected channel at 100 MHz; ≥50:1 at nominal bandwidth. (Measured with an 8-div input signal and equal Volts/div switch settings on both channels from 2 to 500 mV/div.)

Displayed CH 2 Signal Delay With Respect to CH 1 Signal—Adjustable through a range of at least ±500 ps.

Input Z (1 MΩ)—1 MΩ ±0.5% shunted by 15 pF, ±2 pF. Maximum Input Voltage: 400 V (dc+peak ac); 800 V p-p ac at 10 kHz or less, for ac, dc, and ground-coupled signals.

Input Z (50 Ω)—50 Ω ±1%. VSWR (2467/2465A): ≤1.3:1 from dc to 300 MHz; ≤1.5:1 from 300 to 350 MHz. VSWR (2455A/2445A): ≤1.3:1 from dc to nominal bandwidth. Maximum Input Voltage: 5 VRMS, averaged for 1 s; ±50 V peak.

Cascaded Operation—Deflection Factor: 200 μV/div±10%. (For 200 μV/div sensitivity, use 20-MHz bandwidth limit.)

CHANNEL 3 AND CHANNEL 4

Deflection Factor—100 and 500 mV/div ±10%

Frequency Response—Same as Channel 1 and Channel 2. (Responses measured only with standard probe.)

Step Response—Same as Channel 1 and Channel 2

Signal Delay Between CH 1 and Either CH 3 or CH 4—±0.5 ns. (Measured at 50% points.)

Input Z—1 MΩ±1%, shunted by 15 pF±3 pF Maximum Input Voltage: 400 V (dc+peak ac); 800 V p-p ac at 10 kHz or less.

Channel Isolation—≥50:1 attenuation of the deselected channel at 100 MHz. (Measured with an 8-div input signal.)

ALL CHANNELS

Low Frequency Linearity—0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

Bandwidth Limiter—Reduces upper 3 dB bandpass to a limit of 13 to 24 MHz.

Vertical Signal Delay—≥30 ns of sweep displayed before triggering event displayed with Sec/div settings ≥10 ns/div. ≥10 ns of sweep displayed before triggering event displayed with Sec/div settings at 5 ns.

CHOP Mode Switching Rate—2.5 MHz±0.2% sweep speeds ranging from 20 to 2 μs/div; 1 MHz±0.2% all other sweep speeds. (The complete display cycle rate equals the CHOP mode switching rate divided by the number of channels displayed. The CHOP mode switching rate is modulated slightly to minimize waveform breaks with repetitive signals.)

HORIZONTAL SYSTEM

Display Modes—A (main sweep), A INTENsified, ALTernate A Intensified with B (delayed sweep), and B. In X-Y mode, Channel 1 provides X-axis (horizontal) deflection.

A Sweep Time Base Range—2467/2465A: 500 ms/div to 5 ns/div in a 1-2-5 sequence of 25 steps. (X10 magnification extends fastest sweep rate to 500 ps/div.) 2455A and 2445A: 500 ms/div to 10 ns/div in a 1-2-5 sequence of 24 steps. (X10 magnification extends fastest sweep rate to 1 ns/div.)

B Sweep Time Base Range—2467/2465A: 50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. (X10 magnification extends fastest sweep rate to 500 ps/div) 2455A/2445A: 50 ms/div to 10 ns/div in a 1-2-5 sequence of 21 steps. (X10 magnification extends fastest sweep rate to 1 ns/div.)

Variable Timing Control—Continuously variable and calibrated between Sec/div settings. Extends slowest A sweep speed to 1.5 s/div. (Affects the A Sec/div setting with the A display mode; affects the B Sec/div setting with INTEN, ALT, and B modes. The VAR control sets one signal cycle to five divisions for RATIO and PHASE measurements with cursors.)

ΔT Readout Resolution—2467/2465A: Either 10 ps or 0.025% of full scale, whichever is greater. 2455A/2445A: Either 20 ps or 0.025% of full scale, whichever is greater

ΔT Range—With Cursors: ±10 times the A Sec/div setting. With Sweep Delay: ±9.95 times the A Sec/div setting.

Sweep Delay Range—0 to 9.95 times the A Sec/div setting, for settings from 500 ms/div to 10 ns/div (2467/2465A) or from 500 ms/div to 20 ns/div (2455A/2445A). With A Sec/div settings of 50 μs and faster, the A Sweep triggering event is observable on the B Sweep with zero delay setting.

Delay Jitter—2467: Within 0.01% (one part or less in 10,000) of maximum available delay, plus 100 ps. 2465A/2455A/2445A: Within 0.004% (one part or less in 25,000) of maximum available delay, plus 50 ps.

Position Control Range—Start of the 1 ms/div sweep can be positioned from right of graticule center to at least 10 divisions left of graticule center. (Some portion of the sweep is always visible with X10 magnification off.)

TRIGGERING

Trigger Sensitivity From CH 1 or CH 2 Source—DC Coupled: 0.35 div. Noise Reject Coupled: ≤1.2 div. HF Reject Coupled: 0.5 div from dc to 30 kHz. LF Reject Coupled: 0.5 div from 80 kHz. AC Coupled: 0.35 div from 60 Hz. Above 50 MHz: Triggering signal requirement increases to 1.5 div at 500 MHz (for 2467, 2465A, and 2455A) and at 250 MHz (for 2445A) with dc, LF Reject, and ac coupling. For Noise-Reject coupling above 50 MHz, triggering signal requirement increases to 4.5 div at 500 MHz (for 2467, 2465A, and 2455A) and at 250 MHz (for 2445A).

Trigger Sensitivity From ADD Source—2467/2465A/2455A: Add 0.5 div to CH 1 or CH 2 source requirements at 500 MHz.

Trigger Sensitivity From CH 3 or CH 4 Source—2467/2465A/2455A: One-half the CH 1 or CH 2 source requirements.

Trigger Sensitivity From Multiple-Channel Composite Source—2467/2465A/2455A: Add 1.0 div to CH 1 or CH 2 source requirements.

Maximum P-P Signal Rejected by Noise-Reject Coupling Within Vertical Bandwidth—CH 1 or CH 2 Source: ≥0.4 div (with Volts/div settings of 10 mV/div and higher. Maximum noise amplitude rejected is reduced at 2 and 5 mV/div settings). CH 3 or CH 4 Source: ≥0.2 div.

Jitter—2467/2465A: ≤100 ps (with 5 div of 300 MHz at 500 ps/div). 2455A/2445A: ≤100 ps (with 5 div of nominal bandwidth at 1 ns/div).

Level Control Range—CH 1 or CH 2: ±18 ×Volts/div setting; CH 3 or CH 4: ±9 ×Volts/div setting.

Level Readout Basic Accuracy—CH 1 or CH 2 Source: ±[3% of Level setting+3% of p-p signal+0.2 div+0.5 mV+(0.5 mV×probe attenuation factor)]. CH 3 or CH 4 Source: ±[3% of setting+4% of p-p signal+0.1 div+(0.5 mV ×probe attenuation factor)].

Basic accuracies apply from +15 to +35°C and are measured with triggering signals having transition times greater than 20 ns and dc trigger coupling. Add 1.5 mV×probe attenuation factor for temperatures from −15 to +15°C and from +35 to +55°C. Add ±1% of setting from 50 Ω input coupling. Add ±1% of setting with CH 2 Inverted. Add ±0.6 div for CH 1 or CH 2 Source with Noise Reject trigger coupling. Add ±0.3 div for CH 3 or CH 4 Source with Noise Reject trigger coupling.

Maximum Triggering Signal Period

A Sec/div Setting	AUTO LVL Mode	AUTO Mode
<10 ms	≥20 ms	≥80 ms
10 ms to 50 ms	≥4 times A Sec/div	≥16 times A Sec/div
>50 ms	≥200 ms	≥800 ms

X-Y OPERATION

X-Axis Deflection Factor Range, Variable Range, and Accuracy—Same as Channel 1.

X-Axis Bandwidth—DC to 3 MHz.

Input Z—Same as Channel 1.

Phase Difference Between X and Y (With Bandwidth Limiting Off)—≤1° from dc to 1 MHz. ≤3° from 1 to 2 MHz.

X-Axis Low-Frequency Linearity—0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned within the graticule area.

CURSOR AND FRONT-PANEL DISPLAY

Cursor Position Range—ΔVolts: At least the center 7.6 vertical divisions. ΔTime: At least the center 9.6 horizontal divisions.

Z-AXIS INPUT

Sensitivity—DC to 2 MHz: Positive voltage decreases intensity; +2 V blanks a maximum intensity trace. 2 to 20 MHz: +2 V p-p modulates a normal intensity trace.

Input Resistance—9 kΩ ±10%.

Maximum Input Voltage—±25 V peak; 25 V p-p ac at 10 kHz or less.

SIGNAL OUTPUTS

Calibrator—(Measured with the Sec/div setting at 1 ms/div.) Voltage Into 1 MΩ Load: 400 mV±1%. Voltage Into 50Ω Load: 200 mV ±1.5%. Short Circuit Load Current: 8 mA ±1.5%. Repetition Period and Accuracy: Two times the A Sec/div switch setting for settings from 100 ns/div to 100 ms/div ±0.1%, during the sweep time.

Timing Accuracy

For 100 ms/Div and Faster Settings		
Parameter	**+15 to +35°C**	**−15 to +15°C +35 to +55°C**
Unmagnified		
A Sweep*1	±(0.7% of time interval +0.6% of full scale)	±(1.2% of time interval +0.6% of full scale)
ΔT Using Cursors*2	±(0.5% of time interval +0.3% of full scale)	±(0.7% of time interval +0.3% of full scale)
ΔT Using Sweep Delay*3	±(0.3% of time interval +0.1% of full scale)	±(0.5% of time interval +0.1% of full scale)
Delay*4	±(0.3% of delay setting +0.6% of full scale +(0 to −25 ns)	±(0.5% of delay setting +0.6% of full scale +(0 to −25 ns)
Magnified		
A Sweep*5	±(1.2% of time interval +0.6% of full scale)	±(1.7% of time interval +0.6% of full scale)
ΔT Using Cursors*5	±(1.0% of time interval +0.3% of full scale	±(1.2% of time interval +0.3% of full scale)

For the A Sec/div settings of 200 ms and 500 ms, add ±0.5% of time interval or delay setting to preceding specifications.

*1 *Intervals are measured on center horizontal graticule line, and 0.6% of full scale is 0.06 division.*

*2 *Intervasl are measured anywhere on the graticule.*

*3 *Intervals are measured with both delays at 1% or more of full scale from minimum delay (no ? displayed in readout).*

*4 *Delay is from A Sweep trigger point to start of B Sweep.*

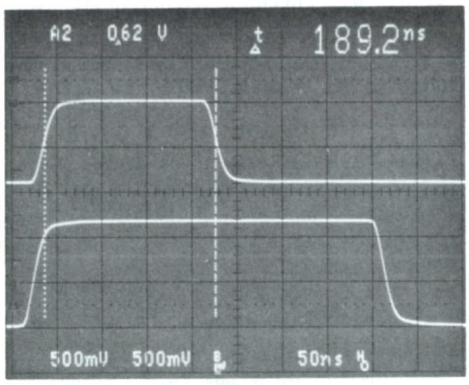
*5 *Exclude the first 0.5 division after sweep starts (first 0.5% of the full 100 division sweep).*

B Sweep Timing Accuracy—Add ±0.3% of time interval to the A Sweep Timing accuracy specifications for Sweep and for ΔT Using Cursors.

Variable Timing Accuracy—Add 2% of time interval to Timing Accuracy specifications for sweep when VAR control is out of detent.

CH 2 Signal Out—Voltage: 20 mV/div ±10% into 1 MΩ. 10 mV/div ±10% into 50 Ω. Offset: ±10 mV into 50 Ω after dc balancing within ±5 °C of the operating temperature.
A Gate Out and B Gate Out—Voltage: 2.4 V to 5 V positive-going pulse, starting at 0 V to 400 mV. Drive: Supplies 400 μA during HI state; sinks 2 mA during LO state.

CRT READOUT AND WAVEFORM INFORMATION



Your eyes never have to leave the screen to obtain front-panel settings and measurement results. In the CRT example above, the top area of the display provides trigger source, trigger voltage level, and Δtime results. The lower area displays the selected volts/div and seconds/div scale factors and that bandwidth limit and holdoff are activated.

CRT AND DISPLAY FEATURES

Standard CRT—2467: 68×85 mm. 2465A/2455A/2445A: 80×100 mm (8×10 cm). Markings: Eight major div vertically and 10 major div horizontally, with auxiliary markings.
Trace Rotation Range—Adequate to align trace with center horizontal graticule line.
Standard Phosphor—GH (P31).
Visual Writing Speed—(2467) With 20 lux=. Illumination Normal to CRT Faceplate (typical room light): ≥4 div/ns (at maximum INTENSITY control setting). (No more than five bright spots will be visible at maximum INTENSITY control setting. Additional bright spots may be visible after displaying a high intensity trace. These spots will extinguish when INTENSITY control is set to minimum.)
Photographic Writing Speed—(2467) ≥10 div/ns with C-30 Series camera and ISO 3000 film, without prefogging. (A single-shot trace of instrument rise time at 500 ps/div is recorded with high contrast at f/1.9.)
Display Intensity Limitation—(2467) Display intensity is automatically reduced and eventually extinguished after periods of no front panel control activity. The time elapsed before intensity reduction is shortened by high intensity settings and high duty factor/sweep speed/trigger rate combinations. Operating any switch or the Intensity control restores the selected intensity setting.

POWER REQUIREMENTS

Line Voltage Ranges—115 V: 90 to 132 V ac; 230 V: 180 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—120 W (180 V ac) for fully-optioned instrument.
Fuse Rating—Either 2 A, 250 V, AGC/3AG, fast-blow or 1.6 A, 250 V, 5×20 mm, quick-acting (Each fuse type requires a different cap.)
Primary Circuit Dielectric Voltage Withstand Test—1500 V rms, 60 Hz, for 10 s without breakdown.
Primary Grounding—Type test to 0.1 Ω maximum. (Routine test to check grounding continuity between chassis ground and protective earth ground.)

ENVIRONMENTAL AND SAFETY

Environmental requirements qualify the electrical and mechanical specifications. When not rack mounted, the instrument meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment (humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4).
Ambient Temperature—Operating: −15 to +55 °C. Nonoperating: −62 to +85 °C.
Altitude—Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1 °C for each 1,000 ft above 1500 m (5,000 ft). Nonoperating: To 15,000 m (50 000 ft).
Vibration—Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz), with frequency varied from 10 to 55 Hz in one-minute sweeps. Held 10 minutes at each major resonance, or if none existed, held 10 minutes at 55 Hz (75 minutes total test time).
Packaged Transportation Vibration—Meets the limits of the National Safe Transit Association Test Procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes per Tektronix Standard 062-2858-00.
Humidity—Operating and Nonoperating: Stored at 95% relative humidity for 5 cycles (120 hours) from +30 to +60 °C, with operational performance checks at +30 and +55 °C.
Shock—Operating and Nonoperating: 50 g's, half-sine, 11-ms duration, three shocks on each face; total of 18 shocks.
Electromagnetic Compatibility—Meets requirements of the following standards: MIL-T-28800C; MIL-STD-461B Part 4 (CE-03 and CS-02), Part 5 (CS-06 and RS-02), and Part 7 (CS-01, RE-02, and RS-03), limited to 1 GHz; VDE 0871 Category B; FCC Rules and Regulations Part 15, Subpart J, Class A; and Tektronix Standard 062-2866-00.
Electrostatic Discharge Susceptibility—Instrument does not change control states with discharges of less than 10 kV. Meets requirements of Tektronix Standard 062-2862-00.
Radiation—Meets requirements of Tektronix Standard 062-1860-00.
Safety—UL listed (UL 1244) and CSA certified (CSA 556B).
Drip Proof—With Cover On: Meets MIL-T-28800C para 4.5.5.5.3.
Transit Drop—Not in Shipping Package: 12-inch drop on each corner and each face (MIL-T-28800C, para 4.5.5.4.2).
Packaged Transportation Drop—Meets the limits of the National Safe Transit Association Test Procedure 1A-B-2; 10 drops of 36 inches per Tektronix Standard 062-2858-00.
Bench Handling—With and Without Cabinet Installed: MIL-STD-810C, Method 516.2, Procedure V (MIL-T-28800C, para 4.5.5.4.3).
Topple—Operating and Cabinet Installed: Set on rear feet and allowed to topple over onto each of four adjacent faces per Tektronix Standard 062-2858-00.
Cooling—Forced air circulation.
Construction—Sheet aluminum-alloy chassis; plastic-laminate front panel; glass-laminate circuit boards.

Ordering Information—See page 314.

PHYSICAL CHARACTERISTICS

	2465A/2467		2455A/2445A		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
Width w/handle	330	13.0	338	13.3	483	19.0
Height w/feet, pouch	190	7.5	190	7.5	178	7.0
w/o pouch	165	6.5	160	6.3		
Depth w/front cover	467	18.4	434	17.1	419	16.5
handle extended	533	21.0	505	19.9		
Weight ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net w/accessories and pouch	10.9	24.0	10.2	22.2	4.0*1	8.8*1
w/o accessories and pouch	9.7	21.3	9.3	20.5		
Shipping	14.6	32.1	12.8	28.2	6.3*1	13.8*1

*1 *Weight of conversion kit only. Rear support kit weight is an additional 6.3 kg (13.8 lb).*

CHARACTERISTICS (OPTION 01)

This option is unavailable for the 2467. The set of characteristics is the same as specified for all other standard 2467/2445A/2465A oscilloscopes and includes the following additions:

All accuracy specifications are stated with an operating temperature range of +18 to +28 °C and a relative humidity of 95% or less.

DC VOLTAGE

Ranges—200 mV, 2 V, 20 V, 200 V, 500 V.
Resolution—10 μV (4½ digits).
Accuracy—±(0.03% of reading +0.01% of full scale). For 500 V range ±(0.03% of full scale).
Input Resistance—>100 GΩ on the 200 mV and 2 V ranges, 10 MΩ on the higher ranges. (Resistance can be changed to 10 MΩ on all ranges.)
Normal-Mode Rejection Ratio—≥ 60 dB at 50 and 60 Hz.
Common-Mode Rejection Ratio—100 dB at dc; >80 dB at 50 and 60 Hz with 1 kΩ imbalance.
Maximum Input Voltage—500 V RMS; 700 V peak between inputs and ground.
Response Time—<2 s in Auto, <1 s in Manual.

AC RMS VOLTAGE

Ranges—200 mV, 2 V, 20 V, 200 V, 500 V.
Resolution—10 μV (4½ digits).
Accuracy—±(% of reading + % of full scale).

Input Frequency	200 mV to 200 V	500 V
20 to 40 Hz	±(0.7% +0.1%)	±(0.7% +0.2%)
40 Hz to 10 kHz	±(0.3% +0.1%)	±(0.3% +0.2%)
10 to 20 kHz	±(0.7% +7%)	±(0.7% +0.2%)
20 to 100 kHz	±(5%+0.1%)	±(5%+0.2%)

Crest Factor—≤4 at full scale.
Common-Mode Rejection Ratio—≥60 dB at 50 and 60 Hz with 1 kΩ imbalance.
Response Time—<3 s in Auto, <2 s in Manual.
Input Impedance—1 MΩ in parallel with <100 pF.
Maximum Input Voltage—500 V RMS; 700 V peak between inputs and ground, not to exceed 10^7 V-Hz product.
dBV, dBm—Calculated reading of ac voltage measurements. dBV equals 20 Log (V_{UNK}/1 V). dBm is referenced 1 mW into 600 Ω.

HI Ω RESISTANCE

Ranges—2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.
Accuracy—±(0.1% of reading +0.01% of full scale) for 2 kΩ to 2 MΩ. ±(0.4% of reading) for 20 MΩ. Add 2% of reading for each 10% Relative Humidity above 70% when in 2 and 20 MΩ ranges.
Maximum Input Voltage—500 V RMS; 700 V peak.
Full-Scale Voltage—2 V.
Open-Circuit Voltage—<6V
Resolution—0.1 Ω (4½ digits).
Response Time—<2 s in Auto, <1 s in Manual, <5 s in 20 MΩ range.

LO Ω RESISTANCE

Ranges—200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ.
Accuracy—±(0.1% of reading +0.1% of full scale) for 200 Ω range. Subtract (0.09% of full scale) for 2 to 200 kΩ ranges. Add (0.15% of reading) and subtract (0.09% of full scale) for 2 MΩ range. Add 2% of reading for each 10% Relative Humidity above 70% when in 200 kΩ and 2 MΩ ranges.
Maximum Input Voltage—500 V RMS; 700 V peak.
Full-Scale Voltage—0.2 V.
Open-Circuit Voltage—<6 V.
Resolution—0.01 Ω
Response Time—<2 s in Auto, <1 s in Manual.
Continuity—An audible tone indicates <10 Ω. Reponse time is ≈0.1 s.

DC CURRENT

Ranges—100 μA, 1 mA, 10 mA, 100 mA, 1 A.
Accuracy—±(0.1% of reading +0.02% of full scale).
Burden Voltage—<150 mV up to 100 mA increasing to <500 mV at 1 A.
Resolution—10 nA.
Response Time—<2 s in Auto, <1 s in Manual.

AC (RMS) CURRENT

Ranges—100 μA, 1 mA, 10 mA, 100 mA, 1 A.
Accuracy—±(0.6% of reading +0.1% of full scale) from 20 Hz to 10 kHz.
Burden Voltage—<150 mV up to 100 mA increasing to <500 mV at 1 A.
Resolution—10 nA.
Response Time—<3 s in Auto, <2 s in Manual.

TEMPERATURE

Range—−62 to +230 °C.
Accuracy—±(2% of reading +1.5 °C).
Resolution—0.1°.
Readout—Selectable in either °C or °F.

OTHER CHARACTERISTICS

Reading Rate—Three readings/s nominal except 1.5 readings/s on 20 MΩ range.
Temperature Coefficient—≤0.1 ×the accuracy specification/°C from −15 to +18 °C and from +28 to +55 °C.
GPIB Compatibility for Semiautomatic Measurement Systems—When combined with Option 10, the DMM (Option 01) oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

Ordering Information—See page 314.

CHARACTERISTICS (OPTION 05)

The set of characteristics is the same as specified for standard 2467/2445A/2465A oscilloscopes and includes the following additions:

VERTICAL SYSTEM (CHANNEL 1 AND CHANNEL 2)

Frequency Response—Applicable for volt/div settings between 5 mV and 0.2 V with Var volt/div control in calibrated detent and using a 5 div, 50-kHz reference signal from a 50 or 75 Ω system.

Range	With Full BW	With BW Limiting
50 kHz to 5 MHz	±1%	+1%, −4%
>5 to 10 MHz	+1%, −2%	*1
>10 to 30 MHz	+2%, −3%	*1
>30 MHz	*1	*1

*1 *Same as basic instrument.*

Square wave Flatness—1% p-p for both 60-Hz and 15-kHz square waves, from a 50 or 75 Ω system using a 1.0 V input with a 50 mV/div setting and using a 0.1 V input at 20 mV/div setting. 1.5% p-p using a 0.1 V input with 5 and 10 mV/div settings. Exclude first 50 ns following step transition. For signals with rise times ≤10 ns, add 2% p-p between 155 and 165 ns after step transition.
Television Blanking-Level Clamp (Back-Porch) 60 Hz Rejection (CH 2 Only)—≥18 dB at 60 Hz; with calibrated Volt/div settings between 5 mV and 0.2 V, and a 6 div reference signal.
Television Blanking-Level Clamp (Back-Porch) Reference—Within 1.0 div of ground reference.

TRIGGERING

Sync Separation—Stable sync separation from sync-positive or sync negative composite video on systems with 525 to 1280 lines/frame, 50 or 60 Hz field rate, interlaced or noninterlaced scan.
Trigger Modes—LINES, FLD 1, FLD 2, and ALT (FLD 1-FLD 2).
Input Signal Amplitude for Stable Triggering—CH 1 and CH 2: 1.0 div for composite video and 0.3 div for composite-sync signals (dc+peak video-signal amplitude must be within 18 div of input ground reference).

CH 3 and CH 4: 0.5 div for composite video and 0.25 div for composite-sync signals (dc peak video-signal amplitude must be within 9 div of input ground reference).
GPIB Compatibility for Semiautomatic Measurement Systems—When combined with Option 10, the TV Waveform Measurement Systems (Option 05) oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

CHARACTERISTICS (OPTION 06 CTT; OPTION 09 CTT/WR)

The set of characteristics is the same as specified for standard 2467/2445A/2465A oscilloscopes and includes the following additions:

Sensitivity—Signal input requirements for Frequency, Period, Totalize, Delay-by-Events and Logic Trigger.

Input	Displayed Signal	Frequency Range
CH 1, CH 2	1.5 div	DC (0.5 Hz for Frequency and Period(to 50 MHz
CH 3, CH 4	0.75 div	
CH 1, CH 2	4.0 div	50 MHz to ≥150 MHz
CH 3, CH 4	2.0 div	

Source—A trigger or word recognizer for Frequency, Period, and Totalize.

FREQUENCY

Range—Autoranging over input frequency from 0.5 Hz to 150 MHz.

Resolution— $\pm\left[\mathrm{LSD}+1.4\times\frac{\mathrm{TJE}}{\mathrm{N}}\times\mathrm{F}^2\right]$

Display—7 digits, updates twice per second or every two periods, whichever is slower.

Accuracy—Resolution ±0.001% of reading over entire temperature range of −15 to +55°C.

PERIOD

Range—Autoranging over an input period from 6.666667 ns to 2 s.

Resolution— $\pm\left(\mathrm{LSD}+1.4\times\frac{\mathrm{TJE}}{\mathrm{N}}\right)$

Display—7 digits (Updates twice per second or every two periods, whichever is slower.)

Accuracy—Resolution ±0.001% of reading over entire temperature range of −15 to +55°C.

ACCURACY AND RESOLUTION DEFINITIONS

F = Input Frequency in Hz

LSD = Least Significant Digit (0.1 ppm of full scale)

TJE = Trigger Jitter Error

N = Number of cycles of measured frequency during measurement interval (0.5 s or 1 period of the input signal, whichever is greater)

TJE (Trigger Jitter Error) =

$$\sqrt{\frac{(\mathrm{en1})^2+(\mathrm{en2})^2}{\text{Input Slew Rate}}}$$

Where: en1 = RMS noise of vertical system in divisions on screen

en2 = RMS noise voltage of input signal in divisions

Volts/div	en1 Trigger Coupling DC and Noise Rej	en1 Trigger Coupling HF Reject
2 mV	0.15 div	0.05 div
5 mV to 5 V	0.1 div	0.05 div

ΔTIME, 1/ΔTIME

Trigger After Delay Accuracy—±(LSD+0.01 ×B Time/div)+(0.001%×A Sec/div+0.001% of reading+50 ps). Measured with visually superimposed signal transitions, >0.1 div/ns trigger-signal slew rates, and with channel-to-channel delay mismatch corrected by the CH 2 DLY match adjustment from the front panel. Independent Slope and Level settings for ΔREF and ΔB triggers allow visual superposition of any pair of points within the center 80% of transitions having at least 5 div amplitude.

Run After Delay Accuracy—±(LSD+0.0008 ×A Sec/div)+(0.01×B Time/div+83 ps). B Time/div includes 10X mag.

Display Update Rate—Auto resolution, twice per second or every four sweeps, whichever is slower. (Depends on trigger and sweep rates with selectable resolution.)

DELAY TIME

Trigger After Delay Accuracy—±(LSD + 0.001% of reading +0.5 ns +A trigger-slew error +B trigger-slew error). Add 0.5 ns for dual-channel measurements.

Where: Trigger-slew error equals trigger-level control readout accuracy ÷ trigger signal slew rate at the trigger point.

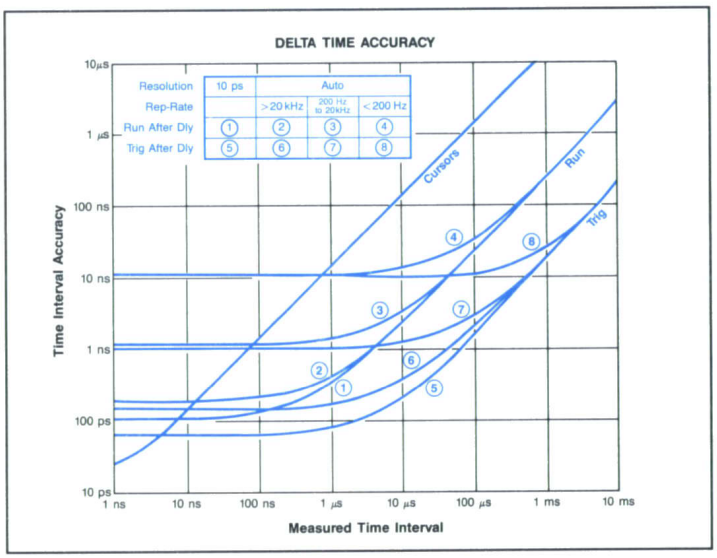
Run After Delay Accuracy—±(LSD +0.0012 ×A Sec/div+0.03×B Time/div +50 ns). (B Time/div includes 10X mag.)

Trigger After Delay and Run After Delay Accuracies Using Word Recognizer on the B Trigger—Add 100 ns if using external clock. Add 200 ns if not using external clock.

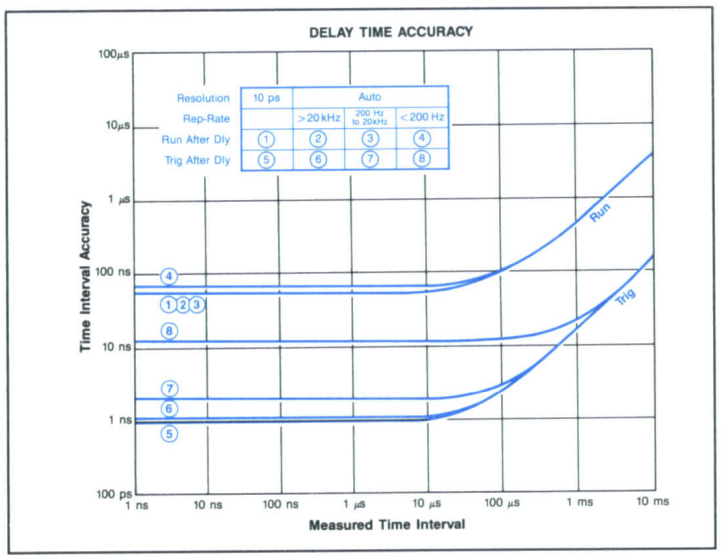
Display Update Rate—Auto, twice per second or once for each sweep, whichever is slower. Depends on trigger and sweep rate for selectable resolution.

Selectable Resolution

A Sec/Div	Selected Resolution	LSD
10 ns to 1 s	AUTO	See Auto Resolution below
10 ns to 5 μs	10 ps 100 ps 1 ns	10 ps 100 ps 1 ns
10 to 50 μs	10 or 100 ps 1 ns	100 ps 1 ns
100 to 500 μs	10 ps to 1 ns	1 ns
1 to 5 ms	10 ps to 1 ns	10 ns
10 to 50 ms	10 ps to 1 ns	100 ns
100 to 500 ms	10 ps to 1 ns	1 μs
1 s	10 ps to 1 ns	10 μs



Input Signal is five vertical div with a 2-ns rise time.
Measured times are four horizontal div.
TJE is negligible for Slew Rates >0.1 div/ns.
ΔTime Trigger After Delay assumes visual superposition.



Input Signal is five vertical div with a 2-ns rise time.
Measured times are four horizontal div.
TJE is negligible for Slew Rates >0.1 div/ns.
ΔTime Trigger After Delay assumes visual superposition.

Auto Resolution

A Sec/Div	Trigger Repetition Rate	LSD
10 ns to 2 μs	>20 kHz	100 ps
10 ns to 2 μs	200 Hz to 20 kHz	1 ns
5 to 200 μs	>200 Hz	1 ns
10 ns to 200 μs	<200 Hz	10 ns
500 μs to 5 ms	Any	10 ns
10 to 50 ms	Any	100 ns
100 to 500 ms	Any	1 μs
1 s	Any	10 μs

2445A Sec/div settings range from 20 ns to 1 s. 2465A Sec/div settings range from 10 ns to 500 ms.

TOTALIZE

Maximum Count—To 9,999,999 events.

DELAY BY EVENTS

A or B Sweep—The A trigger or 17-bit word recognizer defines start events. The B trigger or 17-bit word recognizer defines delay events. With A sweep in the delayed-by-events mode, the B sweep is delayable by time.
Maximum Delay Count—Up to 4,194,303.
Minimum Time From Start Event to Any Delay Event—≥4 ns.
Minimum Pulse Width—≥3.3 ns.

LOGIC TRIGGER

Combination Trigger—A sweep can be triggered from logical combinations of A and B triggers (A and B) or (A or B), or the word recognizer. B sweep can be triggered from the word recognizer.
Minimum Time to Satisfy Logic Combinations—≥4 ns.

WORD RECOGNIZER

Input—P6407 Word Recognizer Probe, 17 bits plus clock. (No CRT display from P6407.)

All Inputs	Threshold	Load	Safe Limit
High	<2.0 V	<20 μA	5.5 V
Low	>0.6 V	>−0.6 mA	−0.5 V

Display Radix—Hexadecimal, octal, binary.
Data Rate—0 to ≥20 MHz with clock, 0 to ≥10 MHz without clock.
Data Set-Up Time—25 ns.
Data Hold Time—0 ns.
GPIB Compatibility for Semiautomatic Measurement Systems—When combined with Option 10 the CTT/WR (Option 09) Oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

Ordering Information—See page 314.

CHARACTERISTICS (OPTION 10)

The set of characteristics is the same as specified for standard 2467/2445A/2465A oscilloscopes and includes the following additions:

Standard Interface Functions Implemented—SH1, AH1, T6, L3, SR1, RL1, DC1, E1 DT0 C0, PP0.
Vertical Position Accuracy—CH 1 and CH 2 (Noninverted): ±[0.3 div +3% of distance (in divisions) from center screen +0.5 mV divided by the Volt/div setting]. For −15 to +55 °C (excluding +15 to +35 °C) add 1.5 mV divided by the Volt/div setting. For CH 2 Inverted add 0.2 div.

CH 3 and CH 4: ±[0.7 div +3% of distance (in div) from center screen].

Ordering Information—See page 315.

CHARACTERISTICS (OPTION 1E)

FREQUENCY

Range—Autoranging over input frequency from 0.5 Hz to 150 MHz.

$$\textbf{Resolution}—\pm\left[\mathrm{LSD}+1.4\times\frac{\mathrm{TJE}}{\mathrm{N}}\,\mathrm{F}^2\right]$$

Display—Seven digits; updates twice per second or every two periods, whichever is slower.
Accuracy—Resolution ±[accuracy of reference×reading]
Definitions:
F=Input frequency in Hz.
LSD=Least Significant Digit (0.1 ppm of full scale.
TJE=Trigger Jitter Error=

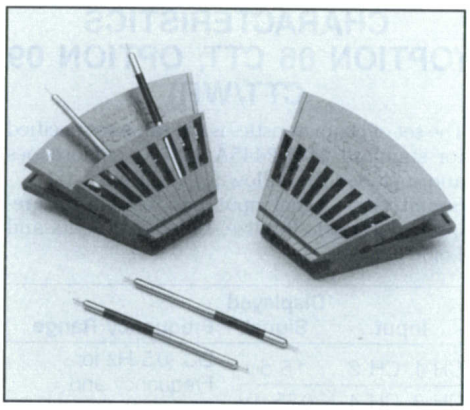
$$\sqrt{\frac{(\mathrm{en1})^2+(\mathrm{en2})^2}{\text{Input Slew Rate}}}$$

N=Number of cycles of measured frequent interval (0.5× or 1 period of input signal, whichever is greater).
en1=RMS noise of vertical system is divisions on screen.
en2=RMS noise of input signal in divisions.

CHARACTERISTICS (OPTION 1R)

ENVIRONMENTAL

Rackmounting changes the temperature, vibration, and shock capabilities. The rackmounted oscilloscope meets or exceeds the requirements of MIL-T-18800C with respect to Type III, Class 5, Style C equipment, when installed as directed. It also meets or exceeds Tektronix Standard 062-2853-00, Class 5 requirements.
Ambient Temperature—Operating: −15 to +55 °C. Measured at the instrument's air inlet, fan exhaust temperature should not exceed +65 °C.
Vibration—Operation: Same as standard instrument, except total displacement is 0.015 inch p-p (2.3 g's at 55 Hz).
Shock—Operating and Nonoperating: Same as standard instrument, except shocks are 30 g's.



KLIPKIT makes high speed IC testing easy. For use directly with P6130 family probes or others vis the included signal pins.

ORDERING INFORMATION

2467*4 350 MHz Oscilloscope **$11,900**
Includes: MCP CRT; four P6136 10X 1.3 m probes with accessories; 2 A, 250 V fuse (159-0021-00); zip lock accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-03); clear plastic CRT filter; snap accessory pouch (016-0692-00); front cover; power cord (161-0104-00); Operator's Manual (070-5854-01).

2465A 350 MHz Oscilloscope **$5,550**
Includes: Two P6136 10X 1.3 m probes with accessories (P6136); 2 A, 250 V fuse (159-0021-00); zip lock accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-03); clear plastic CRT filter; snap accessory pouch (016-0692-00); front cover; power cord (161-0104-00); Operator's Manual (070-6014-01).

2455A 250 MHz Oscilloscope **$5,350**
Includes: Same as 2465A.

2445A 150 MHz Oscilloscope **$3,590**
Includes: Same as 2465A, except two P6133 10X 2 m probes; Option 01, 1.3 m probe

2465A DV 350 MHz Oscilloscope **$9,200**
Includes: Same as 2465A, plus DMM (Option 01), TV (Option 05), CTT/WR (Option 09), GPIB (Option 10), and two additional P6136 probes (Option 22). Provides most cost-effective combination of these options.

2465A DM 350 MHZ Oscilloscope **$8,400**
Includes: Same as 2465A, plus DMM (Option 01), CTT/WR (Option 09), GPIB (Option 10), and two additional P6136 probes (Option 22). Provides most cost effective combination of these options.

2465A CT 350 MHz Oscilloscope **$7,150**
Includes: Same as 2465A, plus CTT/WR (Option 09), GPIB (Option 10), and two additional P6136 probes (Option 22). Provides most cost-effective combination of these options.

INSTRUMENT OPTIONS

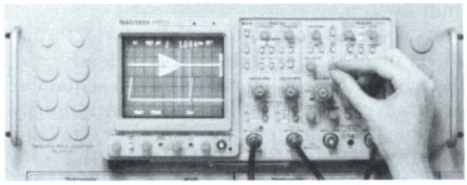
Option 01*3*4—Digital Multimeter + $1,500
Includes: Same as standard instruments, plus probe set (012-0941-00); temperature probe (P6602); probe set accessories (020-0087-00).
Option 05—TV Waveform Measurement System + $1,050
Includes: Same as standard instruments, plus CCIR graticule CRT filter (378-0199-04); NTSC graticule CRT filter (378-0199-05); polarized collapsible viewing hood (016-0180-00).
Option 06— Counter/Timer/Trigger + $1,000
Includes: Same as standard instruments, plus 20 grabber tips (206-0222 00); two 10 inch 10 wide comb (012-0747-00).
Option 09*1*2—Counter/Timer/Trigger and Word Recognizer + $1,400
Includes: Same as standard instruments, plus a word recognizer probe (010-6407-01); 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00).
Option 10—IEEE-488 GPIB Interface + $900
Includes: Same as standard instruments, plus Instrument Interface Guide.
Option 1E—External Clock $200

MULTIPLE OPTION ALLOWANCE (MOA)

When a 2467 or 2465A instrument is ordered with more than two of the above options, a special price allowance is applied. This allowance is not applicable to the 2465A DV, 2465A DM, or the 2465A CT.
Option 2A—MOA for combining two of the above options. − $250
Option 3A—MOA for combining three of the above options. − $500
Option 4A—MOA for combining four of the above options. − $750

OTHER INSTRUMENT OPTIONS

Option B1—Service manual. (For 2445A/2455A/2465A/2467) Standard manual. + $50
(For Options/Special Editions) Includes standard manual plus options manual. + $50
Option 1R*3—Configure Oscilloscope for Rackmount. + $320
Includes: Same as bench model instrument (except pouch) plus rackmount hardware and slide-out assemblies.



Option 1T—Transit Case. + $185
Option 11*1—Rear Panel Probe Power. + $165
Option 22 Two additional probes.
(2467/2465A/2455A) P6136 probes. + $265
(2445A) P6133 probes. + $205

*1 *Option 11 may not be ordered with Option 09 or the 2445A.*
*2 *Option 09 includes Option 06.*
* *Option 1R may not be ordered with Option 01, 2465A DM, or 2465A DV. For rackmounting instruments equipped with Option 01, contact your local Sales Engineer.*
*4 *Option 01 is not available with the 2467.*
NOTE: Options are not retrofittable with field upgrade kits.

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Customer Service Section

M1—(2467/2465A/2455A and Special Editions) 2 Calibrations. + $265
M1—(2445A) 2 Calibrations. + $255
M2—(2467) 2 Years Service. + $370
M2—(2455A/2465A and Special Editions) 2 Years Service. + $270
M2—(2445A) 2 Years Service. + $215
M3—(2467) 2 Years Service and 4 Calibrations. + $845
M3—(2465A/2455A and Special Editions) 2 Years Service and 4 Calibrations. + $695
M3—(2445A) 2 Years Service and 4 Calibrations. + $645
M4—(2467/2465A/2455A and Special Editions) 5 Calibrations. + $670
M4—(2445A) 5 Calibrations. + $660
M5—(2467) 9 Calibrations and 2 Years Service. + $1,495
M5—(2465A/2455A and Special Editions) 9 Calibrations and 2 Years Service. + $1,350
M5—(2445A) 9 Calibrations and 2 Years Service. + $1,295

OPTIONAL ACCESSORIES

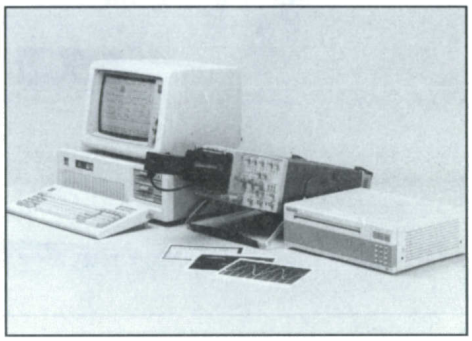
Rackmount Conversion Kit—Not compatible with Option 01. Order 016-0825-01 $370
Probe Power Extender Cable for Rackmount Instrument With Option 11—Order 020-0104-00 $490
Word Recognizer Extender Cable for Rackmount Instrument With Option 09 and 2465A CT—Order 020-0103-00 $350
GPIB Cables—Double shield, low EMC.
(1 m) Order 012-0991-01 $140
(2 m) Order 012-0991-00 $155
(4 m) Order 012-0991-02 $180
Viewing Hoods—
(Polarized Collapsible) Order 016-0180-00 $60
(Folding Light Shield) Order 016-0592-00 $14.25
(Folding Binocular) Order 016-0566-00 $19
Protective Waterproof Vinyl Cover—Order 016-0720-00 $25
Carrying Case—Order 016-0792-01 $360
Carrying Strap—Order 346-0199-00 $17.50
DC Power
1105 $2,090
1106 $1,580
DC Inverter—1107 $1,140

RECOMMENDED PROBES

P6133—10X Passive Probe for use with 2445A. $115
P6136—10X Passive Probe for use with 2467, 2465A, 2455A. $150
P6202A—10X FET Probe. $715
P6230—10X Bias/Offset Probe. $420
P6056—10X, 500Ω Passive Probe for 50 Ω inputs. $200
P6057—100X, 5000 Ω passive probe for 50 Ω input. $195
P6602—Temperature Probe. $235
Current Probes—A6302, A6303, P6021, P6022.
A6901—Ground Isolation Monitor $680
A6902B Voltage Isolator—For floating measurements. $1,885

DIGITIZING CAMERA SYSTEM

DCS01 Option 2A—Digitize waveforms from scope screen. $5,595
S58DC02—2467/DCS Interface GPIB Driver. $295



DCS01 Digitizing Camera System captures repetitive waveforms from analog scopes and transients according to a scope's CRT writing speed (350 MHz for 2467).

RECOMMENDED CAMERAS

C-30BP Option 01—General Purpose. $1,500
C-5C Option—02 Low Cost. $495

RECOMMENDED CART

K212—For on-site mobility. $350

SERVICE MANUALS

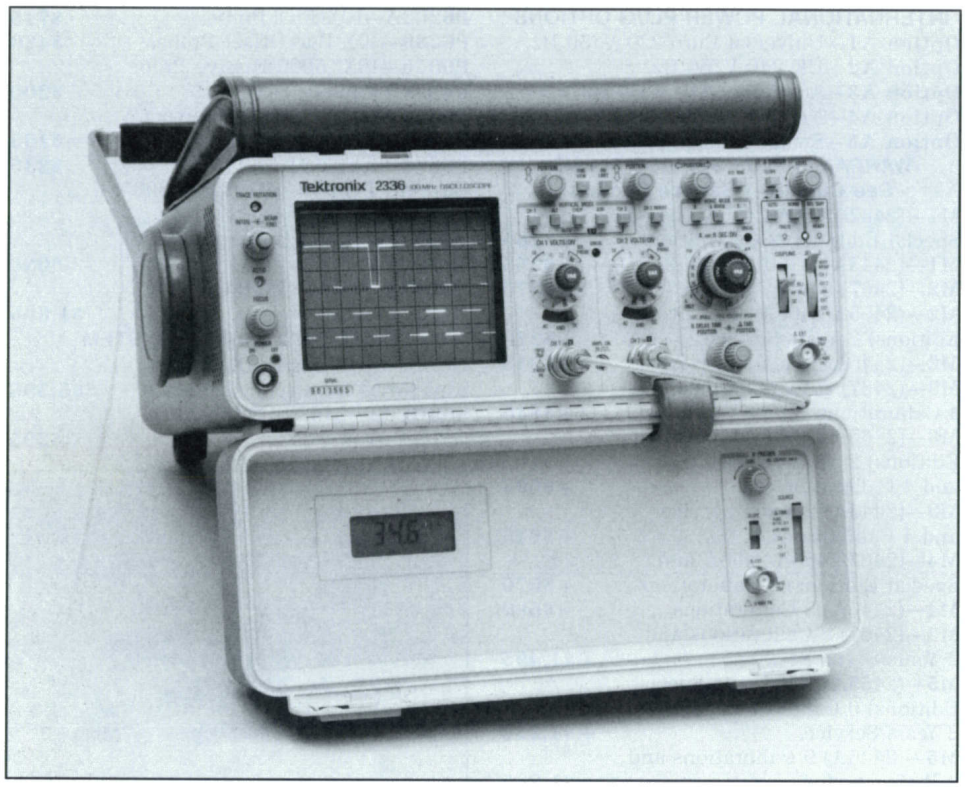
(2467/2465A) Order 070-6019-01 $50
(2455A/2445A) Order 070-6017-01 $50
(Options) Order 070-5857-00 $50

SOFTWARE

EZ-TEK 2400 Test Program Generator—For instruments with GPIB; used with 4041 controller. Order S49F101 $250
EZ-TEK 2400 PC Test Program Generator—For instruments with GPIB; used with IBM PC/XT/AT and compatibles. Requires GURU hardware. Order S49F103 $250
GPIB User's Resource Utility (GURU)—Includes GPIB-PC interface board, GPIB cable, software, and documentation. Order S3FG100 $850

TRAINING

Tektronix Instrument Group customer Training offers operation and application training to help you get full value out of your instrumentation investment. See Customer Service Section for information. For further information, or to enroll, call us at 1-800-835-9433 ext. 430. For international orders contact your local Sales Office.



2335/2336 2336YA/2337

- **DC to 100-MHz Bandwidth**
- **5 mV/Div to 5 V/Div**
- **5 ns/Div Sweep Rate**
- **Three-Year Warranty—Five-Year Option**
- **UL Listed, CSA**

TYPICAL APPLICATIONS

Rugged Field Service
Computer Peripheral Service
Communication Equipment Service

Compact and lightweight for ultra portability, these oscilloscopes are designed and built for on-site troubleshooting. The 2335, 2336, 2336YA, and 2337 are useful for high-speed logic and digital applications. They feature an innovative and protective fliptop cover that doubles as a front panel with ΔTime on the 2336, 2336YZ, and ΔTime/DMM on the 2337 versions. The entire outside case of all four instruments is made of durable, one-piece aluminum and the front panels are coated with scratch-resistant plastic. When the fliptops are latched shut, the entire scope can withstand the abuse and heavy usage of field-service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div. An internal delay line permits observation of the leading edge of a waveform. Variable sweep speeds range from 0.5 s/div to 50.0 ns/div and a 10X magnifier can increase the sweep rate to 5 ns/div. An autotrigger mode allows triggering on waveforms with repetitive rates down to approximately 10 Hz. The sweep rate will run freely and provide a baseline trace in the absence of an adequate trigger signal.

Many exterior features have been incorporated into these new ultra-portable scopes to make them fast and convenient to use. The CRT produces bright, high-resolution traces that are readily visible in most light conditions. The ΔTime/DMM readouts are distinct, backlighted LCD (Liquid Crystal Display) for clear viewing in any lighting condition. All knobs and switches have been located in logical groupsings to avoid errors and delays during operation. Any for the 2336, 2336YA, and 2337 models, ΔTime and DMM display and controls are in the hinged, fliptop cover.

All four oscilloscopes come with detachable power cord, integral EMI shielding, and an accessories pouch. They are manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. These scopes meet the environmental capabilities for Class 3 instruments as prescribed in MIL-T-28800.

2335

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers a three-year warranty on labor and parts including CRT (excluding probes). Beyond the "basic three years" of warranty coverage, Tektronix will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

The 2336YA version of the standard 2336 100-MHz Portable Oscilloscope has a 5000-hour elapsed time indicator installed, and also includes additional accessories and an extra set of manuals. 2300 Series products have National Stock Numbers. Check the Logistics Data Book for information.

CHARACTERISTICS

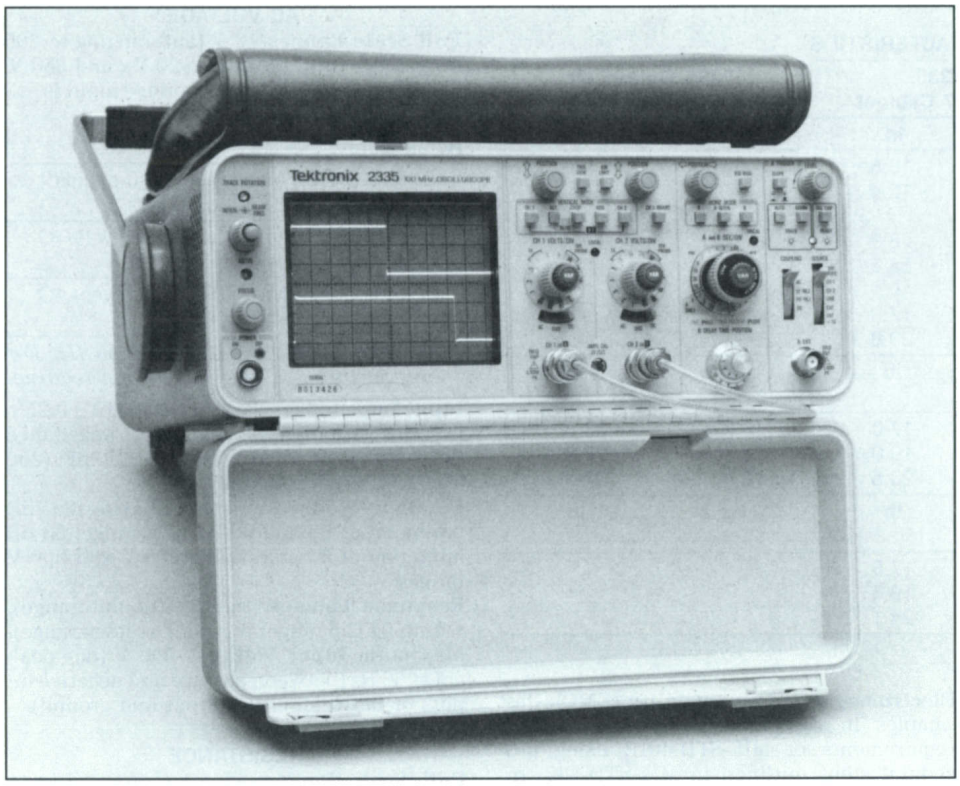
The following characteristics are common to the 2335, 2336YA, and 2337 oscilloscopes except where indicated.

VERTICAL SYSTEM (TWO IDENTICAL CHANNELS)

Bandwidth and Rise Time

−15 to +40°C	+40 to +55°C
dc to at least 100 MHz, 3.5 ns	dc to at least 85 MHz, 4.15 ns

Bandwidth Limit—20 MHz by bandwidth limit switch.
Lower −3 dB Point AC Coupling—1X Probe: 10 Hz or less. 10X Probe: 1 Hz or less.
Deflection Factor—5 mB/div. 1-2-5 sequence. Accuracy ±3%. Uncalibrated: Continuously variable between steps and to at least 2 mV/div.
Display MOdes—CH 1, CH 2, Add CH 2 (normal and inverted), Alternate, Chopped (≈275 kHz rate).
Common-Mode Rejection Ratio (common-mode signals of 6 div or less)—2335, 2336, 2337: ≥25:1 at 10 MHz; 10:1 at 100 MHz.
Channel Isolation—>100:1 at 25 MHz.
Input R and C—1 MΩ ±2% paralleled by 20 pF ±10%.
Maximum Input Voltage—AC or dc coupled, 400 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.



HORIZONTAL SYSTEM

Time Base A—0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

Time Base B—0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

Variable Time Control—Time base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy*1

	+20 to +30°C	−15 to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

*1 *Full ten divisions.*

Display Modes—A, A intensified by B, B delayed.

CALIBRATED SWEEP DELAY

Delay Time Range—Continuous from 50 ns to at least 5 s after start of delaying sweep.

Differential Time Measurement Accuracy*1

	+15 to +30°C	−15 to +55°C
2335	0.75%+0.015 major dial div	1.5%+0.015 major dial div
2336/2337 2336YA	±1% of reading ±1 count	±2.5% of reading ±1 count

*1 *2336YA only: +10 to +55°C is 2% of reading ±1 count.*

Jitter—One part or less in 20,000 (0.005%) of 10 times the A Sweep Time/Div setting.

TRIGGERING

A Trigger Mode—Normal: sweep runs when triggered. Automatic: sweep free-runs in absence of a triggering signal and for signals below 30 Hz. Single Sweep: sweep runs once on first triggering event after reset selector is pressed. (LED indicates when sweep is triggered and when single sweep is ready.)

A and B Trigger Sensitivity

2335,2336 2337	Internal	External*1	External ÷10*1
20 MHz	0.3 div	50 mV	500 mV
100 MHz	1.1 div	150 mV	1.5 V
2336YA			
25 MHz	0.3 div	50 mV	500 mV
100 MHz	1.0 div	150 mV	1.5 V
150 MHz	1.1 div	300 mV	3 V

*1 *External B Trigger sensitivity is not applicable to the 2335.*

Trigger Coupling—AC (−3 dB 20 Hz), dc, LF REJ attenuates signals above 50 kHz. B Trigger coupling is ac only.

A Trigger Holdoff—Adjustable control permits stable presentation of repetitive waveforms

ΔTime B Trigger Modes—(2336, 2336YA and 2337 only): Provides two intensified zones on CRT trace for differential time measurements. Time difference between two intensified zones determined by B Delay Time Position and ΔTime Position controls, and is displayed on LCD readout.

Runs After Delay—B Sweep starts immediately after the delay time selected by the Delay Time Position control and is independent of B trigger signal.

Triggerable After Adjustable Delay Time—B Sweep Trigger sourced from a composite of CH 1 and CH 2; CH 1 only, CH 2 only or from the Ext Trigger input connector.

Jitter—2335, 2336, 2337: 1.0 ns or less at 100 MHz. 2336YA: 0.5 ns at 100 MHz.

A Trigger View—A spring-loaded pushbutton overrides other vertical controls to display the signal used to trigger the A Sweep. This control provides quick verification of the (trigger) signal and permits a time comparison between the vertical input signal and the trigger signal. Deflection Factor is 100 mV/div ±40% (1 V/div with Ext÷10).

Level and Slope—Internal: Permits selection of triggering at any point on positive or negative slope of vertical input signal. Level adjustment: Through at least ±1 V in Ext; through at least ±10 V in Ext÷10.

A Sources—Vertical Mode, CH 1, CH 2, Line, Ext, Ext÷10.

B Sources—(2336, 2336YA and 2337 only) ΔTime runs after delay, Vertical Mode, CH 1, CH 2, Ext (all modes ac coupled).

External Inputs—R and C: 1 MΩ ±10%, 20 pF +30%. 400 V (dc+peak ac) or 500 V ac p-p at 1 kHz or less.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)—5 mV/div to 5 V/div (1-2-5 sequence), accurate ±5% from 0 to +40°C, accurate ±8% from −15 to +55°C. X axis bandwidth: dc to ≥2 MHz. Y-axis bandwidth: dc to >100 MHz. Phase difference between amplifiers: ≤3° dc to 200 kHz.

CRT AND DISPLAY FEATURES

CRT—8×10 div (8 mm/div) display. Horizontal and vertical centerlines further marked in 0.2 div increments. Accelerating potential: 18 kV. GH (P31) phosphor.

Graticule—Internal, nonparallax, nonilluminated; markings for measurement of rise time.

Beam Finder—Compresses trace to within graticule area to locate an offscreen signal.

Z-Axis Input—Positive-going, dc coupled signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 20 MHz.

OTHER CHARACTERISTICS

Amplitude Calibrator—0.2 V accurate ±1% from 0 to +40°C, ±1.5% from −15 to +55°C.

POWER REQUIREMENTS

Line Voltage Ranges—100 to 132 V ac and 200 to 250 V ac. Option 03: 90 to 115 V ac or 180 to 230 V ac.

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—35 W at 115 V, 60 Hz.

PHYSICAL CHARACTERISTICS

	2335, 2336, 2336YA, 2337 Cabinet		2335 Option 1R Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	274	10.8	483	19.0
w/handle	315	12.4		
Height			133	5.2
w/feet/pouch	210	8.3		
w/o pouch	135	5.3		
Depth			378	14.9
w/o front cover	430	17.0		
handle extended	528	20.8		
Weight ≈ (2335)	**kg**	**lb**	**kg**	**lb**
Net w/o accessories or pouch	7.7	17.0	11.7	25.8
Net, w/accessories & pouch	8.6	19.0	12.6*1	27.8*1
Shipping	10.6	23.5	16.9	37.3
Weight ≈ (2336,2336YA,2337)	**kg**	**lb**	**kg**	**lb**
Net, w/o accessories & pouch	8.0	17.8		
Net, w/accessories & pouch	8.9	19.6		
Shipping	10.9	24.1		

*1 *No pouch for 2335 Option 1R.*

ENVIRONMENTAL

The 2335 Oscilloscope meets environmental capabilities for Class 3, type 3, style D instruments as prescribed in MIL-T-28800C. The 2336, 2336YA and 2337 Oscilloscopes meet the environmental capabilities for Class 3, Type 3, Style D instruments as prescribed by MIL-T-28800 except as indicated herein to avoid potential damage to the LCD readout.

Temperature (Forced-air ventilation during normal operation)—2335 Operating: −15 to +55 °C. Nonoperating: −62 to +85 °C.

2335 Option 1R (Rackadapted)—Operating temperature inside equipment rack: −15 to +55 °C. Max exhaust-fan temperature: +65 °C. Nonoperating: −62 to +85 °C.

2236/2237 Operating: −15 to +55 °C. Nonoperating: −40 to +80 °C.

Altitude—Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

Vibration—Test samples subjected to sinusoidal vibration in X, Y, and Z-axes; frequency varied from 10 to 55 to 10 Hz in one minute cycles for 15 minutes. Total displacement: 0.025 in. p-p (4 g's at 55 Hz).

Humidity Operating and Nonoperating—2335: 95%, five cycles (120 hours), referenced to MIL-T-28800B Paragraph 3.9.2.2.

2336, 2336YA and 2337—Operating: 90% (72 hours) at +55 °C.

2336, 2336YA, 2337 and DMM: Operating: 90% (24 hours) at +35 °C and 70% (24 hours) at +50 °C.

2336, 2336YA, 2337 and DMM: Nonoperating: 90% (72 hours) at +60 °C.

Shock—Operating: 50 g's, ½ sine, 11-ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

Electromagnetic Compatibility (EMC)—Test samples in compliance with the Class 3 requirements of MIL-STD-461B using procedural steps outlined in MIL-STD-462. Increase RS03 requirements from 1 V/m to 10 V/m. For RE01, use 500 Hz to 30 kHz in place of 30 Hz to 30 kHz.

2337 With Digital Multimeter

DC VOLTAGE

Full Scale Ranges—2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 500 V.
Resolution—100 μV at 200 mV full scale.

Accuracy

+15 to +35°C	Within ±0.15% of reading ±1 count
−15 to +15°C	Add ±0.01% for every °C below +15°C
+35 to +55°C	Add ±0.01% for every °C above +35°C
>80% Relative Humidity	Add ±0.25% of reading ±3 counts

Input Resistance—10 MΩ ±0.25%.
Rejection Ratio—Normal-Mode: 60 dB minimum at 50 and 60 Hz. Common-Mode: 100 dB minutes at dc, 60 dB minutes at 50 and 60 Hz.
Response Time—Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).
Maximum Input Voltage—500 V (dc+peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

AC VOLTAGE

Full Scale Ranges—2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 350 V.
Crest Factor (When peak voltage input is <3 times full scale)—6.

Accuracy*1

+15 to +35°C	Within ±3%, ±6 counts*1, 20 Hz to 20 kHz
−15 to +15°C	Add ±0.05% for every °C below +15°C
+35 to +55°C	Add ±0.05% for every °C above +35°C

*1 *Nonsine waves: Derate below 50 Hz. For crest factors >3, add +0, −1% of reading.*

Input Impedance—Resistance 10 MΩ ±0.25% in series with input blocking cap. Capacitance (20 V, 200 V, and 350 V range) <150 pF; (200 mV, 2 V range) <220 pF.
Common-Mode Rejection Ratio—60 dB minimum at 50 and 60 Hz, 2 V range; 53 dB minimum at 50 and 60 Hz, 200 V and 300 V ranges.
Response Time—Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).
Maximum Input Voltage—500 V (dc+peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

RESISTANCE

Full Scale Ranges—2 kΩ (autoranging to 200 Ω); 200 kΩ (autoranging to 20 kΩ); 20 MΩ (autoranging to 2 MΩ).
Resolution—0.1 Ω.

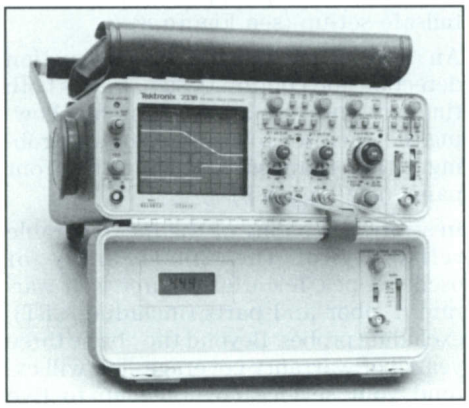
Accuracy

+15 to +35°C	Within ±0.5% ±2 counts +0.4 Ω
−15 to +15°C	Add ±0.05% for every °C below +15°C
+35 to +55°C	Add ±0.05% for every °C above +35°C
>80% Relative Humidity	Add ±1% of reading ±8 counts

Response Time—<4 s.
Maximum Input Voltage—500 V (dc+peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

ORDERING INFORMATION

2335 Oscilloscope $3,940
Includes: Two P6108A 10X probes; accessory pouch (016-0674-00); zip lock accessory pouch (016-0537-00); clear CRT implosion shield (337 2781-00); installed, blue CRT implosion shield (337-2760-00); two 1 A fuses (159-0022-00); ½ A fuse (159-0025-00); power cord (161-0104-00); operator manual (070-4115-00).
2336 Oscilloscope With ΔTime $4,270
Includes: Same as 2335, instruction manual (070-4117-00) instead.

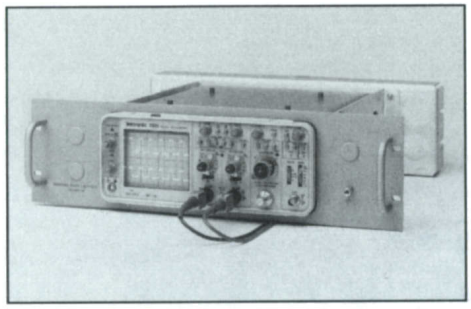


2336YA

2336YA Oscilloscope With ΔTime, Elapsed Time Meter, Extra Accessories and Manuals $4,490
Includes: Same as 2336 plus P6101A probe; three probe tip adaptors (103-0051-01); three spring tip adaptors (206 0060-00); operator manual (070-5010-00); service manual (070-5011-00).
2337 Oscilloscope With ΔTime and DMM $4,700
Includes: Same as 2335, instruction manual (070-4119-00) instead.

OPTIONS

Option 03—100 V/200 V, ac nominal, 48 to 440 Hz. NC



Rackmount 2335 Option 1R.

Option 1R—(2335 only) Rack Conversion. +$375

CONVERSION KIT

Rackmount Conversion— 2335 only. Order 016-0468-00 $315

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

See Customer Service Section

M1—(2335) 2 Calibrations. +$145
M1—(2336/2336YA) 2 Calibrations. +$160
M1—(2337) 2 Calibrations. +$180
M2—(2335) +2 Years Service. +$140
M2—(2336/2336YA) +2 Years Service. +$160
M2—(2337) +2 Years Service. +$180
M3—(2335) +2 Years Service & 4 Calibrations. +$410
M3—(2336/2336YA) 2 Years Service & 4 Calibrations. +$470
M3—(2337) 2 Years Service & 4 Calibrations. +$510
M4—(2335) 5 Calibrations. +$390
M4—(2336/2336YA) 5 Calibrations. +$445
M4—(2337) 5 Calibrations. +$480
M5—(2335) 9 Calibrations +2 Years Service. +$825
M5—(2336/2336YA) 9 Calibrations +2 Years Service. +$940
M5—(2337) 9 Calibrations +2 Years Service. +$1,025

OPTIONAL ACCESSORIES

Battery Pack—Order 1106 $1,580
DC Power—Order 1107 $1,140

RECOMMENDED PROBES

See Probe Section for complete descriptions.
P6108A—10X probe. $75
P6202A—10X FET probe. $715
P6022— Current probe. $495
P6062B—1X/10X probe. $175
A6902B Voltage Isolator—For floating measurements see page 528. $1,885

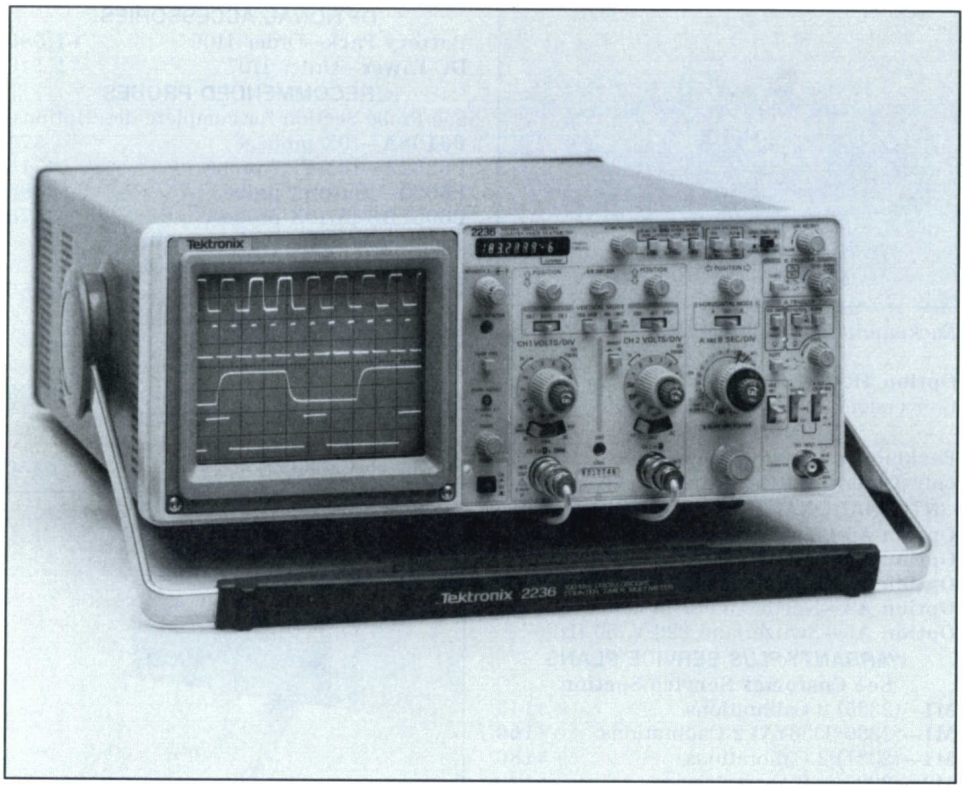
RECOMMENDED CAMERA

C-5C Option 04—Includes 016-0359-01 adaptor and flash (camera mount not provided). $495

RECOMMENDED CART

K212 Portable Instrument Cart—For on-site mobility. $350

K212 Portable Instrument cart



2236

- **DC to 100-MHz Bandwidth**
- **Integrated Counter/Timer/DMM**
- **Lightweight, Easy to Use**
- **2-mV Sensitivity**
- **5-ns/Div Sweep Rate**
- **100-MHz Counter**
- **Gated Counter Measurements/ΔTime**
- **UL Listed, CSA**
- **Channel 1 AC and DC Volts**
- **Full Function DMM—5000 Counts**
- **Three-Year Warranty—Five-Year Option**

TYPICAL APPLICATIONS
Digital Design and Testing
Field Service
Amplifier Design and Testing

The 100-MHz 2236 introduces a new concept in waveform measurement: a 100-MHz counter/timer/DMM, integrated into the scope's vertical, horizontal and trigger systems. This convenient feature simplifies setups (by allowing consolidated set-ups and combinations of measurements) heightens measurement confidence, and expands the scope's versatility. The 2236 replaces mental gymnastics and roundabout problem-solving with simple, direct, accurate, digital readouts that supplement your analog measurements.

The Tek 2236 provides easy, accurate, and versatile measurements through microprocessor-driven waveform analysis. Autoranged and autoaveraged counter/timer measurements are made on the signal triggering the A sweep, or in gated modes, on the signal triggering the B sweep. Autoranged DMM measurements are made through floating DMM side inputs and up-range at 5000 counts. Channel 1 voltage measurements made on Channel 1 signal include: dc, relative dc, relative and true ac RMS voltage. Self testing includes power-on and user interactive routines.

The 2236 uses intensified markers on-screen to define the area to be measured on a burst or short duration pulse train. Gated counter measurements are made via the B trigger with operator prompting and automatic, digital readout of results (see Figures 1, 2, 3). With period averaging the 2236 can make low-frequency measurements instantly, in contrast to the several seconds delay encountered on conventional counter/timers.

The scope and DMM can be applied simultaneously, with concurrent CRT and digital-readout displays. The same probe feeds data to the scope and provides information to the DMM, thus eliminating tangled leads and extra set-up time required to obtain true ac RMS or dc voltage readings (see Figure 4).

DMM autoranging simplifies set-up. An ohmmeter range of 2 GΩ—one hundred times the range of most such devices—allows service technicians to quickly pinpoint even small amounts of transformer leakage, or designers to accurately check the insulating property of capacitors (see Figure 7).

Frequency, period, and width measurements are pushbutton simple, with accuracies to 0.001% and beyond. On-screen operator prompts further ensure failsafe set-up (see Figure 8).

An audible, automatic diode/junction detection and continuity signal saves both time and interpretation errors by allowing the operator to concentrate on probing rather than on observing the front panel (see Figure 9).

In strong testimony of the incomparable reliability of the 2000 Family of oscilloscopes, Tek offers a three year warranty: labor and parts (including CRT), excluding probes. Beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

2235

- **DC to 100 MHz Bandwidth**
- **Lightweight, Easy to Use**
- **2-mV Sensitivity**
- **5-ns/Div Sweep Rate**
- **Advanced Trigger System**
- **Trigger View**
- **Delayed Sweep Measurements**
- **Large, Bright CRT**
- **10X Probes Included**
- **Three-Year Warranty—Five-Year Option**
- **UL Listed, CSA Certified**

TYPICAL APPLICATIONS
Field Service
Design
Component Testing

The 100-MHz 2235 offers high value and high performance. The low price is made possible by the 2200 Series innovative architecture. Yet it has the needed features, operational simplicity and (not least) solid reliability. And all are backed by a three-year warranty on all parts and labor, including the CRT (excluding probes).

The 2235 ensures measurement quality and reliability while reducing instrument cost.

Continued on page 322.

GATED FREQUENCY MEASUREMENT

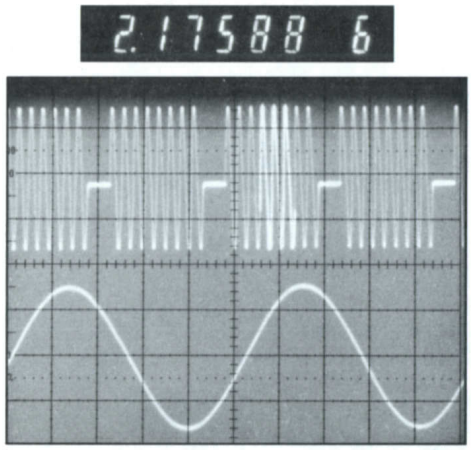


Figure 1. With the B sweep triggered, the frequency within the intensified zone on the A sweep is measured.

GATED PERIOD MEASUREMENT

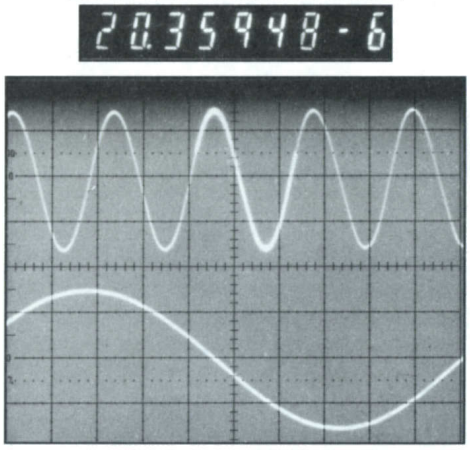


Figure 2. With the B sweep triggered, the period within the intensified zone on the A sweep is measured.

GATED WIDTH MEASUREMENT

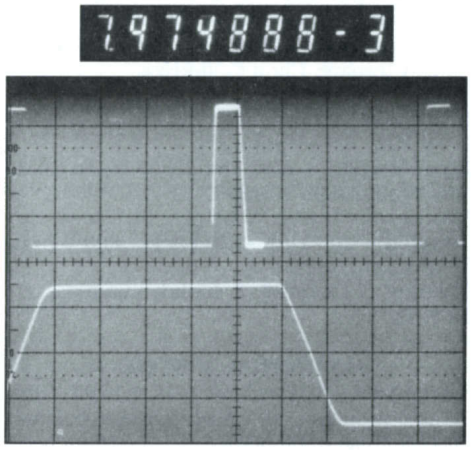


Figure 3. With the B sweep triggered, the width to be measured is within the intensified zone and polarity is selected by the B trigger slope control.

CHANNEL 1 VOLTS MEASUREMENT

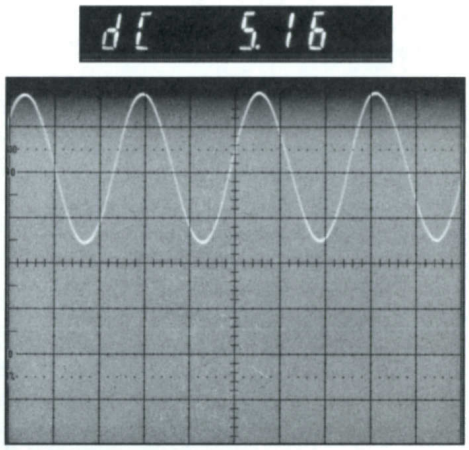


Figure 4. The average dc or true ac RMS component of a waveform is measured directly through channel 1 or from the floating DMM input.

DELAY TIME MEASUREMENT

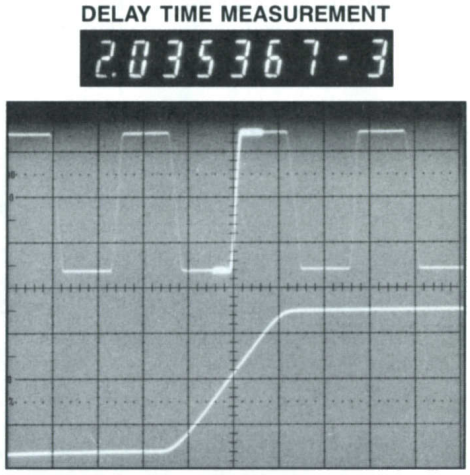


Figure 5. Delay time is measured from the start of the A sweep to the start of the intensified zone.

DELTA TIME MEASUREMENT

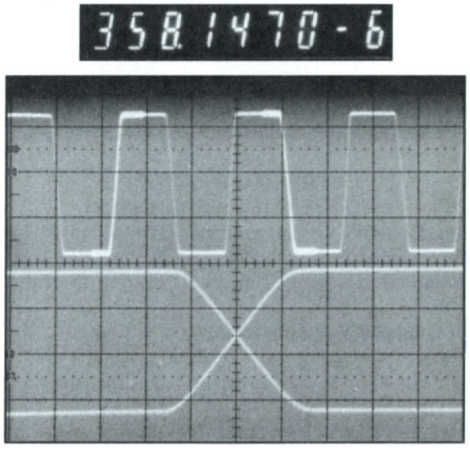


Figure 6. The time between the two intensified zones on the A sweep is measured with up to 10-picosecond resolution.

EXTENDED RANGE RESISTANCE MEASUREMENT

Figure 7. 0Ω (with 0.01 Ω resolution) to 1.99 GΩ, to find hard-to-trace problems like leaky capacitors or malfunctional transformers.

OPERATOR PROMPTING

Figure 8. Error messages and prompts make counter/timer/DMM measurements easier.

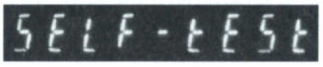
DIODE DETECTION AND TEST

Figure 9. Automatic junction detection during normal resistance measurements first displays "DIODE" and then the forward voltage drop to 1%.

TEMPERATURE MEASUREMENT

With optional P6602 Probe: From −62 to +230°C (−80 to +446°F); resolution to 0.1° (either range).

MICROPROCESSOR DIAGNOSTICS



Automatic power-up and user-interactive diagnostic routines simplify CTM service.

ACCURATE TIME MEASUREMENT

Time base error only 10 ppm (0.001%) standard, and only 0.5 ppm (0.00005%) with optional temperature compensated crystal oscillator.

MEASUREMENT EASE AND ACCURACY

See the measurement you make on the CRT, read the result with digital accuracy on the 9-digit display.

GATED TOTALIZE MEASUREMENT

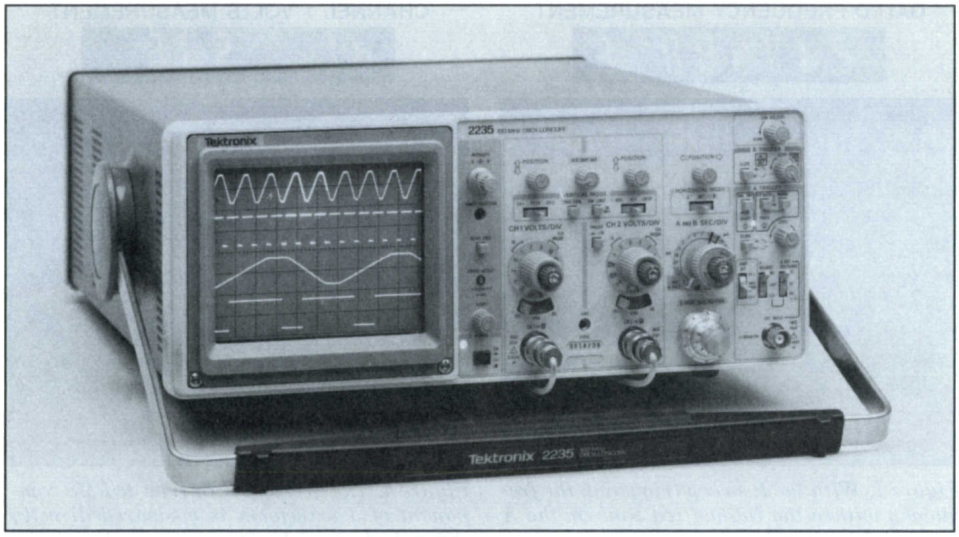
With the B sweep triggered, the events within the intensified portion of the A sweep are totalized. A single events count can be made using single sweep.

CONTINUITY MEASUREMENT

Continuity Measurement Resistances >5 Ω, the massage "OPEN" is displayed. <5 Ω, a tone is generated and the message "SHORT" is displayed.

Tek started with the innovative architecture of the 2200 Series: fewer boards, fewer mechanical parts, less cabling and electrical connectors. This approach, plus advanced circuit design and a focus on essential features, has provided a scope that's more accurate, more reliable, lighter and more serviceable—and simpler to use—than any other 100 MHz scope.

The 2235 delivers 2% vertical and horizontal accuracy in normal operation. Accuracy of 3% or better is maintained across a wide range of environmental extremes. Trace noise, chop noise, vertical aberrations and sweep interference have been reduced to a minimum. Delay jitter of 1:20,000 ensures excellent timing measurement resolution. Triggering is sensitive to 0.3 div at 10 MHz. There's a trigger view for simplifying set-ups; single sweep for photographing transients; bandwidth limit for noisy environments; and a bright, high-resolution 14 kV dome mesh CRT.



Features like rugged design, lightweight, and an easy-to-learn front panel make the 2235 an ideal service scope. In both service and design, it offers the sensitivity for low-level measurements and sweep rates for fast logic families, plus 10:1 variable holdoff range for complex word triggering. And at the bottom line, it offers the price and reliability to significantly lower the cost of owning a quality scope.

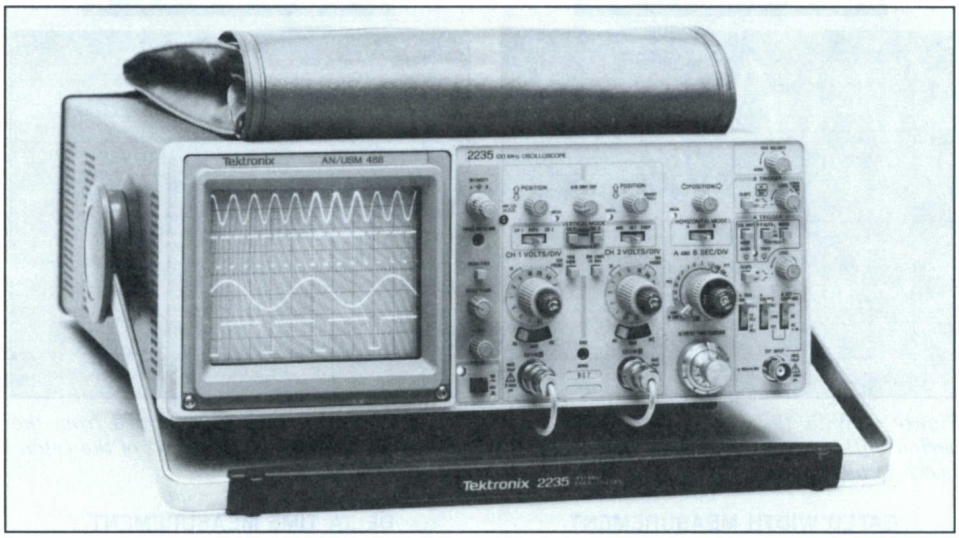
2235 Option 01

(AN/USM-488)

- **Meets or Exceeds MIL-T-28800C and MIL-STD-461B Part 4 for EMC/EMI**
- **DC to 100-MHz Bandwidth**
- **National Stock No. 6625-01-187-7847**
- **UL Listed, CSA Certified**

Comparable in performance to the standard 2235, the 2235 Option 01 version has impressive features. It meets the rigid environmental capabilities for Class 5 instruments as prescribed in MIL-T-28800C. Electromagnetic interference is improved over the standard 2235, and meets MIL-STD-461B part 4 requirements. It has adjustable graticule illumination as well as uncalibrated indicator lights for both the horizontal time base and the vertical channels. HF REJ and LF REJ filtering expand flexibility for trigger coupling.

For your convenience we've also included a protective front-panel cover, accessory pouch, P6101A 1X 2-meter probe, binocular viewing hood, BNC T connector, BNC male-to-binding post, two IC grabber tips and a service manual.



CHARACTERISTICS

The following electrical characteristics are common to the 2236, 2235, and 2235 Option 01 except where noted.

VERTICAL SYSTEM (TWO IDENTICAL CHANNELS)

Bandwidth (−3 dB) and Rise Time—100 MHz and 3.5 ns, derated to 90 MHz at 2 mV/div and outside 0 to +35°C. Bandwidth Limit: 20 MHz ±10%.

Deflection Factor—2 mV to 5 V/div at ±2%. Accuracy derated ±3% outside +15 to +35°C (+10 to +35°C, 2235 Option 01). Continuously variable between steps by at least 2.5:1.

Step Response Aberrations—2235 and 2235 Option 01: +4%, −4%, 4% p-p (2 mV to 0.5 V/div).
2236: +4%, −4%, 4% p-p (5 mV to 0.5 V/div), +5%, −5%, 5% p-p (2 mV/div).

Display Modes—CH 1, CH 2, CH 2 Invert, Add, Alternate, Chop (500 kHz).

Common-Mode Rejection Ratio—At least 10:1 at 50 MHz for signals of 6 div or less (10:1 at 80 MHz 2235 Option 01).

Input R and C—2235 and 2235 Option 01: 1 MΩ, 20 pF. 2236: 1 MΩ, 22 pF.

Maximum Input Voltage (ac and dc Coupled)—400 V (dc+peak ac) or 800 V (p-p to 10 kHz).

Channel 1/Channel 2 Isolation—100:1 at 50 MHz.

HORIZONTAL SYSTEM

Sweep Rate—A Time Base: 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X Mag: 5 ns/div. B Time Base: 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X Mag: 5 ns/div.

Sweep Linearity—±5% over any two of center eight divisions.

Accuracy*1

	+15 to +35°C	0 to +50 °C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

*1 *+10 to +35°C for 2235 Option 01.*

Display Modes—A, Alternate (A Intensified and B Delayed) and B.

CALIBRATED SWEEP DELAY

Delay Time Range—Continuously variable with 10-turn control from <0.5 +300 ns to >10 div.

Differential Delay Time Accuracy—(2235 and 2235 Option 01) ±1% (+15 to +35°C); ±2% (0 to +50°C).

ΔTime Measurement Accuracy—(2236) Max accuracy equal to time base accuracy ±50 ps. Time Base Accuracy With Standard Oscillator: 10 ppm (0.001%); with Option 14 TCXO (Temperature Compensated Crystal Oscillator): 0.5 ppm (0.00005%).

Delay Jitter—2236: 10,000:1 (0.01%). 2235 and 2235 Option 01: 20,000:1 (0.005%).

TRIGGERING

A Trigger Sensitivity

2235/2235-01	Internal	External (p-p volts)
10 MHz	0.3 div*1	35 mV
60 MHz	1.0 div	120 mV
100 MHz	1.5 div*1	200 mV*2
2236		
10 MHz	0.35 div	40 mV
60 MHz	1.2 div	150 mV
100 MHz	1.5 div	250 mV
2236 CTM		
10 MHz	0.5 div	50 mV
60 MHz	1.5 div	160 mV
100 MHz	2.0 div	300 mV

B Trigger (Internal Only) Sensitivity

	10 MHz	60 MHz	100 MHz
2235 & 2235 Opt 01	0.35 div	1.0 div	1.5 div
2236	0.4 div	1.2 div	1.5 div
2236 CTM	0.5 div	1.5 div	2.0 div

*1 *0.35 div for 2235 Option 01.*
*2 *150 mV for 2235 Option 01.*

TV Trigger Sensitivity—TV Field: 1.0 div of composite sync. TV Line: 0.3 div (2235); 0.35 div (2236 and 2235 Option 01).

Bandwidth Limiting (bandwidth limit switch depressed)—20 MHz.

High-Frequency Reject (2235 Option 01 only)—Attenuates signals above 40 kHz.

Low Frequency Reject (2235 Option 01 only)—Attenuates signals below 40 kHz.

Trigger System Operating Modes—Normal, p-p automatic, TV line, TV field, and single sweep.

Trigger View System—Same deflection factors as vertical channels with internal sources; 100 mV/div with ac and dc external, and 1 V/div with dc÷10 external. Accuracy: ±20%. Delay difference between trigger view (EXT input) and either vertical channel: <2.0 ns.

External Trigger Input—Coupling: ac, dc, or dc÷10.

Variable Holdoff Control—Increases A sweep holdoff time at least 10:1.

X-Y OPERATION

Deflection Factors—Same as vertical system (V/div switch in calibrated detent).

Accuracy

	Y-Axis	X-Axis
+15 to +35°C	±2%	±3%
0 to +50°C	±3%	±4%

Bandwidth—Y-Axis: same as scope's vertical system. X-Axis: 2.5 MHz.

Phase Difference Between X-Axis and Y-Axis Amplifiers—±3° from dc to 150 kHz with dc coupled inputs.

CRT AND DISPLAY FEATURES

CRT—8×10 cm display; internal unilluminated graticule (2235 Option 01 is illuminated). Accelerating potential: 14 kV. GH (P31) phosphor standard.

Controls—Beam Finder, Focus, Separate A and B Sweep Intensity, Trace Rotation. 2235 Option 01 also has Variable Scale Illumination.

Z-Axis Input—DC coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation; dc to 20 MHz.

OTHER CHARACTERISTICS

Probe Adjust Signal—(2235/2236) Square wave, 0.5 V ±5%, 1 kHz ±20%.

Amplitude Calibrator—(2235 Option 01 only) Square wave, 0.5 V ±2%, 1 kHz ±20%.

POWER REQUIREMENTS

Line Voltage Range—90 to 250 V ac. (No line switches or fuse changes needed.)

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—2235: 40 W, 70 VA. 2236: 60 W, 110 VA.

DC Operation—12 to 30 V available with 1105, 1106, and 1107.

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +50°C (except 2236 CTM ac RMSV, DCV, and Ω Modes: 0 to +40°C) Nonoperating: −55 to +75°C.

Altitude—Operating: To 4600 m (15,000 ft). Maximum operating temperature decreased 1° C/1,000 ft (5,000 to 15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Vibration—Operating: 15 minutes along each of the major axes. 0.015-in. p-p displacement 10 to 55 to 10 Hz in one minute cycles. Held for 10 minutes at 55 Hz (2.4 g's at 55 Hz).

Humidity—Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800C, Paragraph 4.5.5.1.2.2.

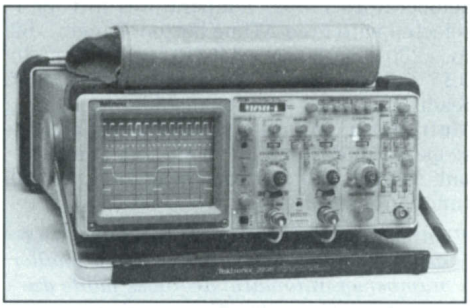
Shock—Operating: 30 g's, ½ sine, 11-ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

EMC—Meets Class B requirements per VDE 0871B for radiated and conducted emission. 2235 Option 01 AN/USM 488 Only: Meets requirements of MIL-STD-461B Part 4, CE03, CS01, CS02, CS06, RE02 (to 1 GHz), and RS03 (1 V/meter to 1 GHz).

PHYSICAL CHARACTERISTICS

	2235 & 2235 Opt 01		2236	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width*1	328	12.9	328	12.9
Height*3	137	5.4	137	5.4
Depth*2	440	17.3	440	17.3
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	6.1	13.5	7.3	16.2

*1 *Without handle.*
*2 *Without front cover.*
*3 *2235 Option 01 height with pouch is 150 mm (5.9 in.).*



CHARACTERISTICS

The following characteristics are unique to the 2236.

Time Base Accuracy—Standard: 10 ppm (0.001%). With Option 14 TCXO: 0.5 ppm (0.00005%).

Frequency—Range: ≤0.2 Hz to ≥100 MHz. Maximum Resolution: 0.00001 Hz. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1*2

Period—Range: ≥5 s to ≤10 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1*2

Width—Range: ≥5 s to ≤5 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±10 ns. Can be gated.*1*2

Delay Time—Range: ≥2.5 s to ≤500 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±20 ns.*2

ΔTime—Range: ≥2.5 s to ≤1 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±50 ps.*2

Totalize—Over 8,000,000 events. Can be gated.

DC Volts—Range: 0 to 500 V. Maximum Resolution: 100 μV. Accuracy: ±0.1%. Input: Through side DMM leads.*2

RMS AC Volts—AC Coupled: True RMS with 20 Hz to 20 kHz frequency range. Range: 0 to 350 V. Maximum Resolution: 100 μV. Accuracy: ±1.0%. Input: Through side DMM leads.*2

CH 1 Volts—Measures average dc voltage (with CH 1 dc coupling) or true RMS voltage (with CH 1 ac coupling); 1X/10X ranged by coded probes: Single Sweep button zeros display and permits relative dc and ac RMS measurements. Range, dc and ac Volts: 0 to 50 V (500 V dc/350 V ac with P6121 10X Probe). Maximum Resolution, dc and ac Volts: 100 μV (1 mV with P6121). Maximum Accuracy, dc Volts (18 to 28 °C): ±0.3% with 1X probe, ±0.5% with 10X probe. Maximum Accuracy, ac Volts with 1X probe (18 to 28 °C): ±2%, 50 to 100 Hz, ±1%, 100 Hz to 20 kHz. Maximum Accuracy, ac Volts with 10X Probe: ±2%, 20 Hz to 20 kHz, with proper probe compensation.*2

Resistance—Range: 0 Ω to 1.99 GΩ. Maximum Resolution: 0.01 Ω. Accuracy: To 0.15%. Automatic diode detection displays forward voltage drop to ±1%; continuity mode activates tone if resistance is <5 Ω.*2

Temperature—Uses Optional Tektronix P6602 Temperature Probe. Temperatures in C or F selected with Freq/ΔTime button. Range: −62 to +230 °C (−80 to +446 °F). Resolution: To 0.1° (either range). Accuracy: To ±2% of reading ±1.5 °C; ±2% of reading ±2.70 °F.

Multimeter Inputs—Isolated from oscilloscope ground. Input Z: 10 MΩ. Maximum Input Voltage: 500 V (dc+peak ac), for all functions.

*1 *Ranges, resolutions, and accuracies can be degraded due to gating errors and a smaller number of automatic averages made during a gated frequency, period, or width measurement. For complete formula specifications see operator's manual.*

*2 *For complete accuracy and resolution error formula specifications see operator's manual.*

ORDERING INFORMATION

2236 Oscilloscope With Counter/Timer/Multimeter **$2,795**
Includes: Two P6121 10X voltage probes; DMM leads; Reference Guide; Operator Manual (070-4205-00).

2235 Oscilloscope **$1,575**
Includes: Two P6122 10X voltage probes; Operator manual (070-4207-00).

2235 Option 01 Oscilloscope (AN/USM-488) Order 2235L **$2,195**
Includes: Two P6122 10X Voltage Probes (015-0467-00); P6101A 1X Voltage Probe (010-6101-03); viewing hood (016-0566-00); BNC T-connector (103-0030-00); BNC male to binding post (103-0033-00); front panel cover (200-2520-00); accessory pouch (016-0677-02); two grabber tips (013-0191-00); Operator Manual (070-4976-00); Service Manual (070-4977-00).

OPTIONS

Option 02—(2235, 2236 only) Front panel cover and accessory pouch. **+$50**

Option 14—(2236 only) TCXO Temperature-Compensated Crystal Oscillator, 0.5 ppm accuracy. **+$315**

Option 33—Travel Line Package
Includes rubber molding, accessory pouch, front panel cover, carrying strap.
(2235) **+$200**
(2236) **+$295**
(2220/2230) Includes rubber molding, carrying strap. **+$245**

CONVERSION KITS

Rackmount Adapter—
Includes: Rackmount depth extenders, all mounting hardware, labels, instruction manual.
(2335) Order 016-0466-00 **$130**
(2235 Option 01) Order 016-0833-00 **$145**
(2236) Order 016-0015-00 **$290**

TCX0 Retrofit Kit—(2236 only) Temperature compensated crystal oscillator, 0.5 ppm accuracy.
Order 040-1136-00 **$370**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz. Order 020-0859-00. **$26**

Option A2—UK 240 V, 50 Hz. Order 020-0860-00. **$37**

Option A3—Australian 240 V, 50 Hz. Order 020-0861-00. **$27**

Option A4—North American 240 V, 60 Hz. Order 020-0862-00. **$30**

Option A5—Switzerland 220 V, 50 Hz. Order 020-0863-00. **$19**

WARRANTY-PLUS SERVICE PLANS
See Customer Service Section

M1—(2235/2235 Option 01) 2 Calibrations. **+$135**
M1—(2236) 2 Calibrations. **+$160**
M2—(2235/2235 Option 01) +2 Years Service. **+$125**
M2—(2236) +2 Years Service. **+$150**
M3—(2235/2235 Option 01) 2 Years Service & 4 Calibrations. **+$380**
M3—(2236) 2 Years Service & 4 Calibrations. **+$450**
M4—(2235/2235 Option 01) 5 Calibrations. **+$385**
M4—(2236) 5 Calibrations. **+$425**
M5—(2235/2235 Option 01) 9 Calibrations +2 Years Service. **+$805**
M5—(2236) 9 Calibrations +2 Years Service. **+$900**

OPTIONAL ACCESSORIES

Front Panel Cover and Accessory Pouch*1—Order 020-0672-02 **$50**

Front Panel Cover*1—Order 200-2520-00 **$6.50**

Accessory Pouch*1—Order 016-0677-02 **$33**

Viewing Hoods—
(Collapsible) Order 016-0592-00 **$14.25**
(Binocular) Order 016-0566-00*1 **$19**
(Polarized) Order 016-0180-00 **$60**

Carrying Strap—Order 346-0199-00 **$17.50**

Carrying Case*2—Order 016-0792-01 **$360**

Rackmount Adaptor Kits—
(2235) Order 016-0466-00 **$130**
(2235 Option 01) Order 016-0833-00 **$145**
(2236) Order 016-0015-00 **$290**

CRT Light Filter—
(Clear*1) Order 337-2775-01 **$1.95**
(Blue) Order 337-2775-00 **$3.80**

1107 Mounting Kit—Order 016-0785-00 **$55**

1107 DC Inverter—See end of this Section **$1,140**

1106 Battery Pack—See end of this Section **$1,580**

1105 Power Supply—See end of this Section **$2,090**

A6901 Ground Isolation Monitor—See Accessories Section. **$680**

A6902B Voltage Isolator—See Accessories Section. **$1,885**

RECOMMENDED PROBES

See Probe Section for additional probes.
P6121—10X Probe. **$100**
P6122—10X Probe. **$58**
P6420—DMM RF. **$155**
40 kV DMM—Order 010-0277-00 **$180**
P6602 Temperature Probe—For use with 2236 CTM. **$235**

RECOMMENDED CAMERAS

C-5C—See Accessories Section.
(2235 Option 01) C-5C Option 02 **$465**
(2235, 2236) C-5C Option 04 **$495**

C-7—See Accessories Section.
(2235, 2236) C-7 Option 02 **$595**
(2235 Option 01) Option 03 **$565**

C-4—(2235 Option 01) See Accessories Section. **$375**

RECOMMENDED CART

K212—For on-site mobility. See Accessories Section. **$350**

SERVICE MANUALS

(2235) Order 070-4206-00 **$26**
(2236) Order 070-4204-00 **$28**

*1 *Standard with the 2235 Option 01 (AN/USM-488).*

*2 *Recommend use with front panel cover (200-2520-00).*

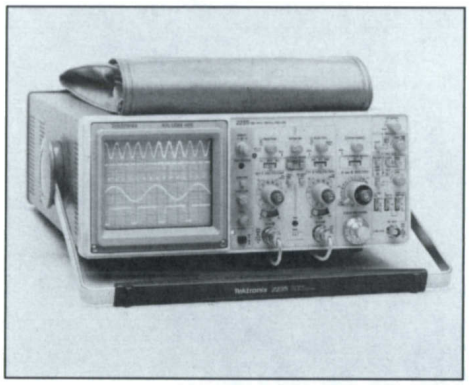
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

MILITARY AND SPECIAL SERVICE OSCILLOSCOPES

2235 Option 01

- DC to 100 MHz Bandwidth
- Fully Provisioned Through the U.S. Army System
- Meets or Exceeds MIL-T-28800C and MIL-STD-461B Part 4 for EMC/EMI
- Three Year Warranty—Five Year Option
- National Stock Number 6625-01-187-7847
- UL Listed CSA

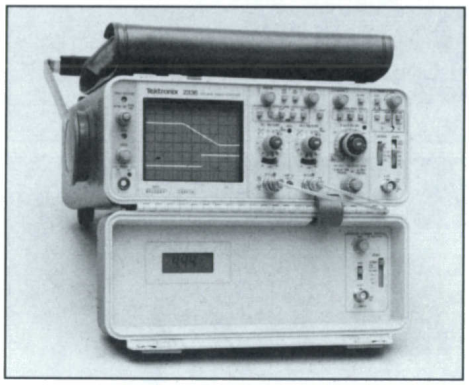
For complete description see this section.



2336YA

- DC to 100 MHz Bandwidth
- 5 mV/Div to 5 V/Div
- 5-ns/Div Sweep Rate
- Rugged for Field Service
- Three Year Warranty—Five Year Option
- Meets MIL-T-28800C, Class 3
- National Stock Number 6625-01-172-6119
- UL Listed, CSA

For complete description see this section.



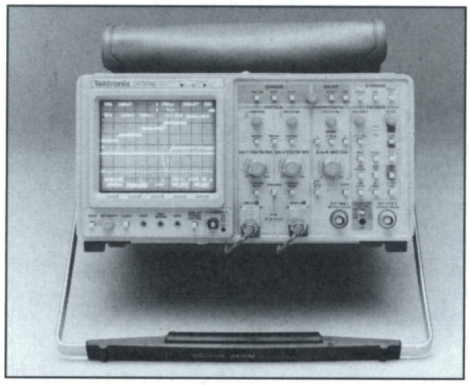
2430M Digital Oscilloscope

GPIB IEEE-488

The 2430M complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- Imbedded CILL/MATE Capabilities
- 150-MHz Bandwidth at Probe Tip
- 5-ns/Div Sweep Speed
- 100-MS/s Sample Rate
- Simultaneous Acquisition of Two Channels
- Envelope Mode With 2-ns Glitch Capture
- 8-Bit Resolution Over 10 Divisions
- Save on Delta (Tek Patented Feature) Provides Unattended Pass/Fail Testing and Babysitting Against a User Defined Reference or Envelope

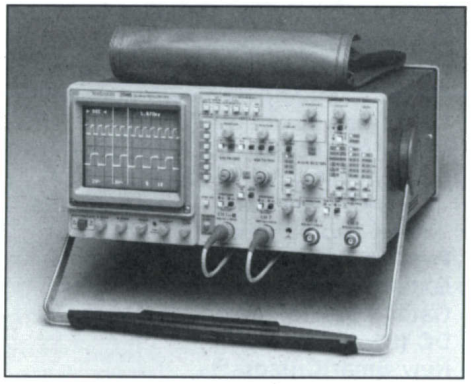
For complete description see this section.



NEW 2246 Option 1Y

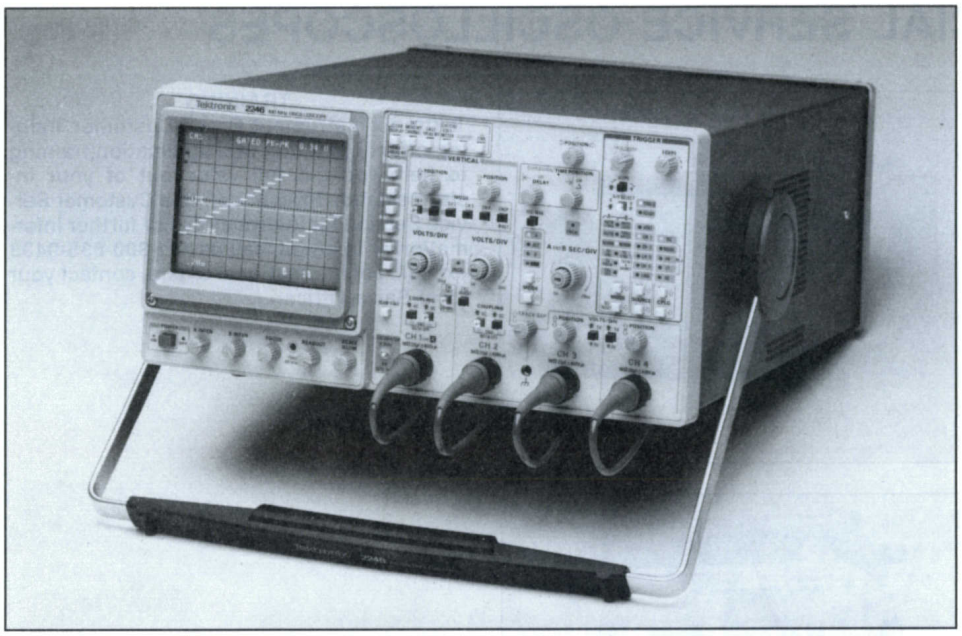
- DC to 100 MHz Bandwidth
- 4 Independent Channels
- 2 ns/Div Time Base
- 2 mV to 5 V/div
- Voltmeter Measurements
- Tracking Smart Cursors
- ΔTime with Cursors or Alternate Sweep
- Meets MIL-28800C, Type III, Class 3
- UL Listed
- Three-Year Warranty

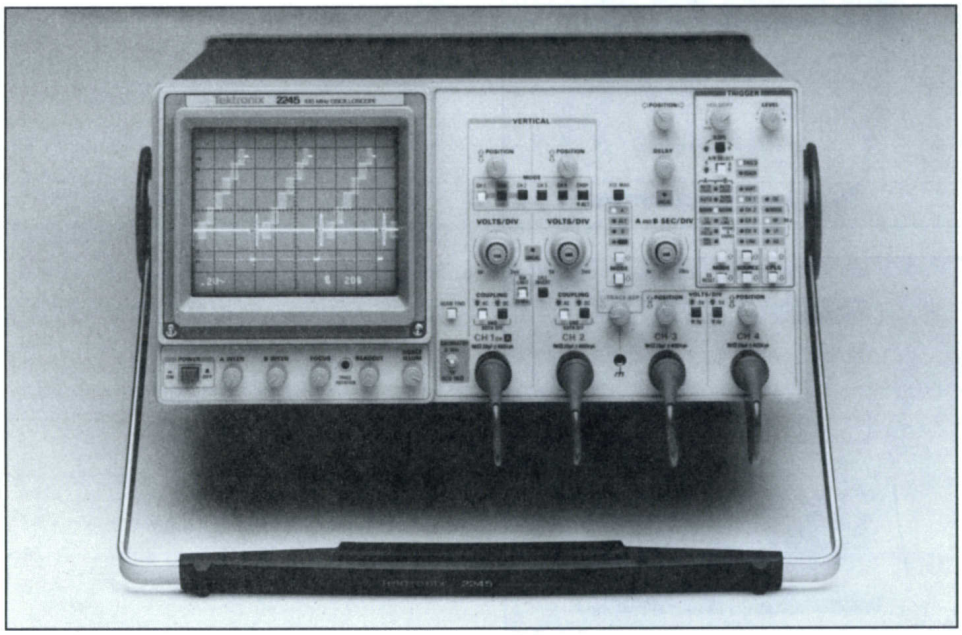
For complete description see this section.



TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. See Customer Service Section for information. For further information or to enroll, call us at 1-800-835-9433 ext 430. For international orders, contact your local Sales Office.





2246/2245

- Bright, Crisp Display With High Writing Rate
- Four Independent Channels
- 100-MHz Bandwidth With 2-ns/Div Time Base
- On-Screen Scale-Factor Readouts
- Flexible Triggering
  Auto Level and Auto HF, LF, Noise Reject, TV Line and TV Field
- Delayed Sweep
- Control Status Lights
- 2% Vertical and Horizontal Accuracy
- 2 mV/Div Vertical Sensitivity at Full Bandwidth
- Specially Designed Probe Improved, Rugged Tip Hybrid Circuitry for Improved Performance
- New Labeled Volts Cursors With Ground-Referenced Readings and On-Screen Readouts (2246)
- Meets or Exceeds MIL-28800 for Harsh Environments (2246 Opt 1Y)
- Hands-Off Voltmeter Measurements
  +Peak and −Peak
  Peak-to-Peak
  Gated Peaks
  Gated Peak-to-Peak
  DC (2246)
- New SmartCursors™
  Track Voltmeter Measurments
  Visually Indicate Trigger Level and Ground (2246)
- Time Measurements With Cursors or Alternate Delayed Sweep ΔTime
- Three-Year Warranty—Five-Year Option
- UL Listed, CSA Certified

TYPICAL APPLICATIONS
Logic Design and Repair
Communications
Power Supply Design

Higher Performance, Lower Price

The performance/price ratio for portable oscilloscopes has been substantially upgraded. No other portable scope can offer the range of productivity enhancing features and performance characteristics at a comparable low price than the Tektronix 2245 and 2246.

Features That Promote Productivity

Four independent channels speed troubleshooting and design tasks by allowing simultaneous observation of multiple test points. Front-panel set-ups are simplified by pushbutton-activated functions and on-screen scale factor readouts. With buttons that light up, settings can be verified at a glance.

More Triggering Flexibility

Hands-free triggering, made possible by the Auto-Level mode, automatically places a stable display of almost any waveform on screen. The LF, HF, and Noise Reject modes, together with a 10-to-1 holdoff range, deliver stable triggering on complex waveforms. The built-in TV Line and TV Field triggering capability extends measurements to most video-related applications with performance for the broadcast industry.

Performance Plus

The NEW 2245 and 2246 oscilloscopes have low-noise vertical systems that produce sharp, bright traces. Their 2-ns time base and 100-MHz bandwidth bring out the details on high-speed signals and render measurements with good timing resolution.

Low-level signal measurements are easily managed by the 2 mV/div vertical sensitivity, even at full bandwidth, and by trigger sensitivity that extends to 0.25 div at 50 MHz (1.0 div at 150 MHz).

Voltage Measurements With the Push of a Button

A pushbutton-activated measurement system on the 2246 enhances productivity even more. This scope turns out virtually hands-off measurements quickly of +peak, −peak, peak-to-peak, dc, and gated volts, all with convenient on-screen readout of values.

If more visual indication is desired, the unique cursor system can provide feedback showing exactly where on the waveform an automatic measurement is being made. These feedback cursors, when selected, even show ground and trigger-level locations.

There is also the ability to use cursors in the conventional manual mode for making point-to-point time and voltage measurements, including time-interval measurements between a point on the reference waveform and a point on any of four other displayed waveforms.

Three-Year Warranty

As with all of our high quality 2000 Series Oscilloscopes, the 2245 and 2246 (including the CRT) are covered by the Tektronix three-year instrument warranty, making ownership more cost effective than ever.

CHARACTERISTICS

Characteristics are common to both the 2245 and 2246, except where indicated.

VERTICAL SYSTEM

Display Modes—CH 1, CH 2, CH 3, CH 4, Add (CH 1+CH 2), Invert (CH 2), Alternate and Chopped display switching for all channels, and 20-MHz bandwidth limiting

CHANNEL 1 AND CHANNEL 2

Frequency Response (−3 dB Bandwidth)—100 MHz: 0 to +35°C; 90 MHz: +35 to +50°C
AC Coupled Lower −3 dB Frequency—10 Hz or less with 1X probe. 1 Hz or less with standard accessory 10X probe.
Step Response—≤3.5 ns for temperatures from 0 to +35°C. ≤3.9 ns for temperatures from +35 to +50°C (rise times calculated from: $t_r = 0.35/BW$).
Deflection Factor Range—2 mV/div to 5 V/div in a 1-2-5 sequence of 11 steps.
Maximum Error—±2% 15 to 35°C (add ±1% from 0 to 15°C and from 35 to 50°C).
Variable Range—Continuously variable between Volts/Div step settings. Increases step setting by at least 2.5 V/div.
Uncalibrated Indicators—>symbol appears on-screen when deflection factor is between calibrated Volts/Div step settings.
Channel Isolation—50 dB or more attenuation of deselected channel at 10 MHz. 34 dB or more at 100 MHz (measured with an eight div input signal and equal Volts/Div settings on both channels from 2 mV/div to 0.5 V/div).
CH 2 Signal Delay With Respect to CH 1—<100 ps difference.
Input Characteristics—1 MΩ ±0.15% shunted by 20 pF ±0.5 pF. Maximum Input Voltage: 400 V (dc+peak ac); 800 V ac p-p at 10 kHz or less.
Common-Mode Rejection Ratio (ADD Mode With CH 2 Inverted)—At least 10:1 at 50 MHz. (for common-mode signals of eight div or less and with Var Volts/Div control adjusted for best CMRR at 50 kHz at any Volts/Div setting).
Trace Drift—Between Volts/Div Step Settings: 0.2 div or less. Var Volts/Div Rotated Between Extremes: 1 div or less. Inverting CH 2: 1 div or less. Between Gnd and DC Input Coupling: <0.5 mV from 0 to +35°C; <2 mV from 35 to 50°C.
Position Range—At least ±11 div from graticule center.

CHANNEL 3 AND CHANNEL 4

Frequency Response—Same as CH 1 and CH 2.
Step Response—Same as CH 1 and CH 2.
Deflection Factor—Settings: 0.1 V/div and 0.5 V/div.
Maximum Error—Same as CH 1 and CH 2.
CH Isolation—34 dB or more attenuation of deselected channel at 100 MHz (measured with an eight div input signal).
CH 4 Signal Delay With Respect to CH 3—<100 ps difference.
Input Characteristics—1 MΩ ±1% shunted by 2 pF ±0.5 pF (maximum Input Voltage: 400 V (dc+peak ac); 800 V p-p ac at 10 kHz or less)
Trace Shift—Between Volts/Div Settings: 1 div or less.
Position Range—Same as CH 1 and CH 2.

ALL CHANNELS

Low Frequency Linearity—≤0.06 div compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.
Bandwidth Limiter—Reduces upper −3 dB bandpass to a limit of 17 to 23 MHz.
Trace Separation Range—±4 div.
Chop Mode Switching Rate—625 kHz±10%.
CH 3 or CH 4 Signal Delay With Respect to Either CH 1 or CH 2—<200 ps difference.

HORIZONTAL SYSTEM

Display Modes—A (main sweep), A Alternate with B (delayed sweep), and B. In X-Y mode, CH 1 provides X-axis (horizontal) deflection.
A Sweep Time Base Range—0.5 s/div to 20 ns/div in a 1-2-5 sequence of 24 steps. X10 magnification extends fastest sweep rate to 2 ns/div.
B Sweep Time Base Range—5 ms/div to 20 ns/div in a 1-2-5 sequence of 21 steps. X10 magnification extends fastest sweep rate to 2 ns/div.
Variable Timing Range—Continuously variable between Sec/Div calibrated step settings. Extends slowest A sweep and B sweep speeds by a factor of a least 2.5 times. Affects the A Sec/Div setting with the A display mode; affects the B Sec/Div setting with the Alt and B modes.

A Sweep Timing Accuracy*1

Range	Unmagnified	Magnified
+15 to +35°C	±2%	±3%
0 to +15°C +35 to +50°C	±3%	±4%

*1 *Applies over the center eight div. Excludes the first 0.25 div of the magnified sweep and sweep beyond the 100th magnified div.*

Linearity—±5% over any two of the center eight div, on both unmagnified and magnified displays.
Delay Time—Range: <0.1 div to >10 div of the A sweep. (Maximum value does not exceed end of the A sweep.) Jitter: 1:20,000 p-p (0.005%) (viewed over two seconds).
ΔTime—Range: 0 to >9.9 div to right of the delay time setting (does not exceed end of the A sweep) Accuracy: ±(0.5% of reading +1% of one A sweep div).

TRIGGERING

Trigger Sensitivity from CH 1, CH 2, CH 3, CH 2 Source.
DC Coupled—0.35 div or greater triggers from dc to 50 MHz, increasing to 1 div at 150 MHz
Noise Reject Coupled—0.8 div or more triggers; 0.5 div or less does not trigger.
HF Reject Coupled—0.35 div or greater triggers from dc to 50 kHz; 0.25 div or less does not trigger above 500 kHz.
LF Reject Coupled—0.35 div or greater triggers from 100 kHz to 50 MHz; 0.35 div or greater does not trigger from dc to 10 kHz.
AC Coupled—0.35 div or greater triggers from 50 Hz and 50 MHz; 0.35 div or less does not trigger from dc to 5 Hz.

For dc, LF Reject, and ac coupling above 50 MHz, triggering signal requirement increases to 1.0 div at 150 MHz.
Trigger Sensitivity From TV Line or TV Field Source—0.5 div or less of composite sync achieves stable display.
Lowest Usable Frequency With Auto Level Function—10 Hz.
Level Control Range—±20 div (referenced to the selected source).
Level Readout Accuracy—±(0.3% of reading +0.1 div).
Variable Holdoff Range—Increases the A sweep holdoff time by at least a factor of 10.

X-Y OPERATION

Deflection Factors—Same as vertical system (Var Volts/Div in calibrated detent).

Maximum Error

Range	Y-Axis	X-Axis
+15 to +35°C	±2%	±3%
0 to +15°C +35 to +50°C	±3%	±4%

X-Axis −3 dB Bandwidth—3 MHz or more.
Phase Difference Between X and Y—≤3° (for dc coupled signals from dc to 50 kHz with bandwidth limiter off).

CURSOR AND FRONT PANEL DISPLAY

Controls—Separate A Intensity, B Intensity, Readout Intensity, Focus, Beam Finder, Trace Rotation, and Scale Illumination.
CRT—8×10 cm internal graticule. Markings: 8 major div vertically and 10 major div horizontally, with auxiliary markings.
Standard Phosphor—GH (P31).
Y-Axis Orthogonality—≤0.1 div over eight vertical div; no adjustment.

Cursor Functions

Function	Accuracy
Sec; 1/Sec; Phase; ΔTime; Δ1/Time; ΔPhase	±(0.5% of reading +0.02 horizontal div)
Volts; Ground Volts (2246 only)	±(0.5% of reading +0.02 vertical div+HF display errors)

Function	Position Accuracy*[1]
Track Measurement, Trig Level, Ground (2246 only)	±0.05 vertical div

*[1] *Cursor position on waveform vs readout displayed value.*

EXTERNAL Z-AXIS INPUT

Active Region Lower Threshold—≤1.8 V.
Signal Required to Blank Sweep-Related L Trace—≥3.8 V.
Input Resistance to Ground—10 kΩ ±10%.
Maximum Input Voltage—30 V (dc+peak ac) or ≤30 V ac p-p at 1 kHz.

CALIBRATOR OUTPUT

Voltage Into 1-MΩ Load—0.5 V ±2%.
Repetition Range—1 kHz +10%.
Overshoot—≤0.1%.

POWER REQUIREMENTS

Line Voltage Range—90 to 250 V ac.
Line Frequency—48 to 445 Hz.
Fuse Rating—2 A, 250 V, slow-blow.
Maximum Power Consumption—80 W (110 V ac).

ENVIRONMENTAL

Environmental requirements qualify the electrical and mechanical specifications. When not rackmounted, the instrument meets the environmental capabilities of a Type III, Class 3, Style D instrument as prescribed by MIL-T-28800C.
Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −50 to −75°C.
Altitude—Operating: To 4500 m (15,000 ft). Maximum operating temperature decreases 1°C for each 300 m (1,000 ft) above 1500 m (5000 ft). Nonoperating: to 15 250 m (50,000 ft).
Vibration—Operating: 15 minutes along each of three axes, 0.015 inch p-p displacement. 10 to 55 Hz in one minute sweeps. Held for 10 minutes at 55 Hz (2.4 g's at 55 Hz).
Humidity—Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800C, Paragraph 4.5.5.1.2.2 for Type III, Class 3.
Shock—Operating and Nonoperating: 30 g, half sine, 11-ms duration; three shocks on each face, for a total of 18 shocks.
Bench Handling Test—4 inch drop per Tektronix Standard 062-2858-00.
Transportation Drop and Vibration—Meets the limits of Tektronix Standard 062-2858-00.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width w/handle	361	14.2
Height w/feet & pouch	177	7.0
w/o pouch	164	6.4
Depth w/front cover	445	17.5
w/handle extended	519	20.4
Weight ≈	**kg**	**lb**
Net w/accessories & pouch	8.9	19.6
w/o accessories & pouch	7.9	17.4

2246 With Voltmeter

DC Volts—Accuracy: ±(0.3% of reading +0.02 div). Normal Mode Rejection Ratio: >50 dB at 50 and 60 Hz.
+Peak and −Peak Volts—Accuracy: ±(2% of reading +0.1 div) for signals from 20 Hz to 30 MHz. −3 dB at 100 MHz. Gated Region Minimum Width: ≤(0.2 div +50 ns).
P-P Volts—Accuracy: ±(2% of reading +0.1 div) for signals from 20 Hz to 30 MHz. −3 dB from 30 to 100 MHz. Gated Region Minimum Width: ≤(0.2 div +50 ns).

ORDERING INFORMATION

2245—100 MHz Oscilloscope **$1,775**
Includes:—Two 10X, 1.5 m probes with accessories (P6109 Opt 01); clear accessories pouch (016-0537-00); blue plastic CRT filter (337-2775-00); 2A, 250 V fuse (159-0023-00); Operator Manual (070-6276-00).
2246—100 MHz Oscilloscope with Voltmeter, ΔTime, and SmartCursors™ **$2,400**
Includes:—Two 10X, 1.5 m probes w/accessories (P6109 Opt. 01); clear accessories pouch (016-0537-00); blue plastic CRT filter (337-2775-00); 2 A, 250 V fuse (159-0023-00); Operator's Manual (070-6083-00); User Reference Guide (070-6081-00).

OPTIONS

Option 02—Protective front panel cover and accessory pouch. **+$50**
Option 1C—C-5C Option 02 Camera. **+$465**
Option 1K—K212 Portable Instrument Cart. **+$330**
Option 1T—Transit Case. **+$215**
Option 22—Two additional P6109 probes. **+$116**
Option 23—Two 1X/10X P6062B, 6 ft probes. **+$350**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

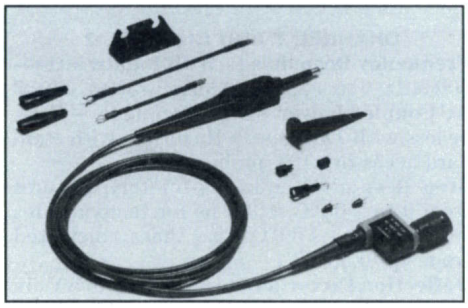
M1—(2245) 2 Calibrations. **+$145**
M1—(2246) 2 Calibrations. **+$160**
M2—(2245) 2 Years Service. **+$175**
M2—(2246) 2 Years Service. **+$185**
M3—(2245) 2 Years Service and 4 Calibrations. **+$290**
M3—(2246) 2 Years Service and 4 Calibrations. **+$320**
M4—(2245) 5 Calibrations. **+$385**
M4—(2246) 5 Calibrations. **+$410**
M5—(2245) 9 Calibrations + 2 Years Service. **+$1,005**
M5—(2246) 9 Calibrations + 2 Years Service. **+$1,095**

OPTIONAL ACCESSORIES

Service Manual (2245/2246) Order 070-6081-00 **$26**
Front Panel Cover—Order 200-3232-00 **$6.00**
Accessory Pouch—Order 016-0857-00 **$46**
Accessory Pouch and Cover—Order 020-1515-00 **$65**
Protective Waterproof Vinyl Cover—Order 016-0848-00 **$15.25**
Viewing Hoods—
(Collapsible) Order 016-0592-00 **$14.25**
(Binocular) Order 016-0566-00 **$19**
(Polarized) Order 016-0180-00 **$60**
Clear Implosion Shield—Order 337-2775-01 **$1.95**
Carrying Strap—Order 346-0199-00 **$17.50**
Carrying Case—Order 016-0792-01*[1] **$360**
Clear Graticule Filter—Order 337-2775-01 **$1.95**
1107 DC Inverter—See page 333. **$1,140**
1106 Battery Pack—See page 332. **$1,580**
1105 Power Supply—See page 332. **$2,090**
*[1] *Recommend use with front panel cover (200-2520-00).*

RECOMMENDED PROBES

See Probe Section for additional probes.



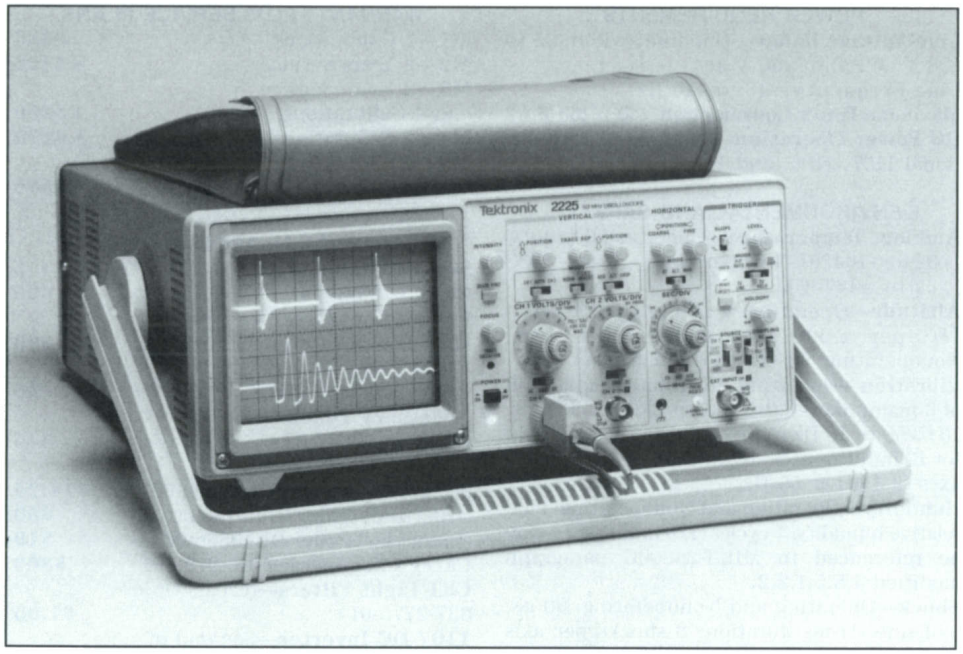
The P6062B allows switching between 1X and 10X attenuation. Readout display changes with attenuation switching.
P6109 (Opt 01)—10X Probe. **$58**
P6062B—1X-10X Probe. **$175**
P6008—Environmental Probe. **$250**
P6009—High Voltage Probe. **$205**
P6202A—Active Probe. **$715**
1101A—Active Probe Power Supply. **$435**
A6302—Current Probe. **$595**
A6303—Current Probe. **$1,125**
AM 503—Current Probe Amplifier. **$1,185**
A6901 Ground Isolation Monitor—See Accessories Section. **$680**
A6902B Isolator—See Accessories Section. **$1,885**

RECOMMENDED CAMERAS

C-5C Option 02—See Accessories Section. **$465**
C-7 Option 03—See Accessories Section. **$565**
C-4—See Accessories Section.

RECOMMENDED CART

K212—For on-site mobility. See Accessories Section. **$350**



2225

- **DC to 50-MHz Bandwidth**
- **Alternate Magnification**
- **500-μV/Div Sensitivity**
- **HF/LF Reject Trigger Filters**
- **Lightweight—Easy to Use**
- **P-P Auto Triggering**
- **5 ns/Div Maximum Sweep Rate**
- **Front Panel Z-Axis Input**
- **Three Year Warranty—Five Year Option**
- **UL Listed, CSA Certified**

TYPICAL APPLICATIONS

Field Service
Education
Production Test
Television Service
Communications

Tektronix' innovation redefines the meaning of value with the 50-MHz 2225. The 2225 continues in the 2200 Series tradition of high performance, reliability, and quality.

The technology that made the 2200 Series the most successful oscilloscopes in the world has been utilized in the 2225. The use of fewer mechanical parts, cables, connectors, and components contributes to improved reliability, serviceability, and cost. The result is a high performance easy-to use scope that costs less to build, buy, and own. You will significantly improve your utility while lowering your cost-of-ownership.

In this day and age when everything is becoming more complex, the 2225 has made strides to increase operational simplicity. This is a big plus in education, field service, and manufacturing production-test environments.

All this and new features too. Features like Alternate Magnification, 500 μV/div vertical sensitivity with X10 magnification, independent trigger coupling, high- and low-frequency reject, front-panel Z-axis input, and a new improved bright, crisp CRT.

Alternate Magnification is an exciting new concept in performing waveform expansion and detailed signal analysis. Dual time base types of measurements can be performed with the simple flip of a switch. The CRT alternately displays both the unmagnified and magnified sweeps. Magnification can be selected in three levels: X5, X10, and X50. Measurements like digital signal timing can be performed with little effort, quickly and accurately.

The new low noise vertical system can operate at 500 μV/div (4 times the maximum sensitivity of the previous 2200 Series). X10 vertical magnification provides benefits similar to those usually associated with the horizontal axis. Vertical waveform expansion is made easy with a pull knob. Independent channel bandwidth limiting (5 MHz) is performed with this function. Now you can selectively limit either channel's bandwidth without affecting the other.

All the features and performance you've come to expect in more expensive instruments is available on the 2225: flexibility and high sensitivity of the trigger system, the convenience of hands-free triggering with Peak-to-Peak Auto, independent selection of TV Line or Field triggering at any sweep speed, variable Holdoff for triggering on complex waveform periods, and a 5 ns/div (maximum) horizontal system that is accurate as well as linear.

The 2225 also includes two new P6103 10X modular probes that complement its performance. They incorporate a new ruggedized probe tip and eliminate the usual bulky compensation box at the front of the scope.

Also consider the world-renowned Tektronix service and support organization. You can find support in any area you need from expert sales support, training materials, application assistance, service and calibration, as well as long-term support for a minimum of 6 years after the product is discontinued.

Tektronix backs the reliability of the 2225 with a three-year instrument warranty that includes all parts and labor including the CRT. Beyond the "basic three years," Tek offers you a choice of five practical service plans to further reduce your cost-of-ownership.

CHARACTERISTICS

All specifications are rated over all environmental extremes except where noted.

VERTICAL SYSTEM
(Two Identical Channels)

Bandwidth (−3 dB) and Rise Time

	5 to 35°C	0 to 40°C
5V to 5 mV/div 2225	50 MHz (7.0 ns)	40 MHz (8.8 ns)

Bandwidth in X10 MAG is reduced to 5 MHz ±20%.
Bandwidth Limit (−3 dB)—5 MHz ±20% (via X10 MAG).
Deflection-Factor Accuracy—(0 to 40°C) 5 mV to 5 V/div: ±3%. X10 Magnification: ±5%. Uncalibrated Variable: Continuously variable between steps by at least 2.5:1.
Step Response Aberrations—+5%, −5%, 5% p-p (5 mV to 0.5 V/div).
Display Modes—CH 1, CH 2, CH 2 Invert, Add, Alt, Chop (500 kHz).
Common-Mode Rejection Ratio—For signals of 6 divisions or less, at least 10:1 at 20 MHz
Input R and C—1 MΩ, 25 pF.
Maximum Input Voltage—400 V (dc+peak ac) or 800 V p-p to 10 kHz (ac and dc coupled).
Channel Isolation—>100:1 at 20 MHz.

HORIZONTAL SYSTEM

Time Base—0.05 μs to 0.5 s/div in 1-2-5 sequence. Maximum Sweep Rate (X10 magnification): 5 ns/div. Uncalibrated Variable: Continuously variable between steps by at least 2.5:1.

Sweep Accuracy

	15 to 35°C	0 to 40°C
Unmagnified X1	±3%	±4%
Magnified X5, X10	±4%	±5%
Magnified X50	±5%	±8%

Sweep Linearity—Specified over any 2 of the center eight divisions. Unmagnified X1: ±5%. Magnified X5, X10: ±7%. Magnified X50: ±9%.
Display Modes—X1, Alternate Magnification, Magnified.
Alternate Magnification—Display alternates between unmagnified (X1) and magnified sweep. Magnification Levels: X5, X10, and X50. Magnifier Registration: Expansion occurs at center vertical graticule line.
Magnification Range—Magnification performed over any portion of the X1 (unmagnified) sweep.

TRIGGERING

Trigger Sensitivity

	Internal	External
5 MHz	0.3 div	40 mV
20 MHz (2205)	1.0 div	150 mV
50 MHz (2225)	1.0 div	150 mV

TV Trigger Sensitivity—TV Field: 1.0 div of composite sync. TV Line: 0.3 div or 40 mV p-p external.
Trigger Operating Modes—Peak-to-Peak Automatic, Normal, TV Field, TV Line, Single Sweep.
Trigger Sources—Internal CH 1, CH 2, Vert Mode, Line, External, and External÷10.
Trigger Coupling—AC, DC, HF REJ (attenuates signals above 30 kHz), LF REJ (attenuates signals below 30 kHz).
Variable Holdoff—Increases X1 Sweep holdoff time by at least 8:1.

X-Y OPERATION

Deflection Factors—Same as vertical deflection system.
Accuracy—(0 to +40°C) Y-Axis: ±3%. X-Axis: ±5%.
Bandwidth—Y-Axis: Same as vertical deflection system. X-Axis: DC to 2.0 MHz.
Phase Difference Between X and Y axis—Amplifiers: ±3° dc to 150 kHz.

CRT AND DISPLAY FEATURES

CRT—8×10 cm; internal graticule; GH (P31) phosphor. Accelerating potential 12.6 kV.
Z-Axis—5 V causes noticeable modulation; positive voltage decreases intensity. Usable Range: DC to 5 MHz.
Controls—Intensity, Focus, Beam Find, Trace Rotation.

OTHER CHARACTERISTICS

Amplitude Calibrator—Square wave, 0.5 V ±5%, 1 kHz ±20%.

POWER REQUIREMENTS

Line Voltage Range—One line switch: 95 to 128 V ac/190 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—40 W (60 V A).
DC Power Operation—12 to 30 V with optional 1107, 1106, and 1105.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: 0 to 40°C (+32 to +104°F). Nonoperating: −55 to +75°C (−67 to +167°F).
Altitude—Operating: 4 500 m (15,000 feet). 1°C per 1,000 feet above 5,000 feet. Nonoperating: 15 000 m (50,000 feet).
Vibration—Operating: 15 minutes along each of 3 major axes. 0.015-inch p-p displacement. 10 to 55 to 10 Hz in one-minute sweeps. Held for 10 minutes at 55 Hz in each of the 3 major axes (2.4 g's at 55 Hz).
Humidity—Operating and Nonoperating: 95% relative humidity. 5 cycles (120 hours) spec may be referenced to MIL-T-28800C paragraph modified 4.5.5.1.2.2.
Shock—Operating and Nonoperating: 30 g's, half-sine, 11-ms duration, 3 shocks per axis each direction, Total shocks: 18.
EMC—Meets Class B requirements per VDE 0871 for radiated and conducted emissions.
Safety—UL Listed, CSA Certified.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width		
w/handle	385	15.2
w/o handle	327	12.9
Height	138	5.4
Depth	443	17.4
w/handle	511	20.3
Weight ≈	**kg**	**lb**
Net	6.5	14.3
Shipping	8.5	18.7

ORDERING INFORMATION

2225 50-MHz Oscilloscope **$995**
Includes: Two P6103 10X voltage probes; Operator Manual (070-6298-01)

OPTIONS

Option 02—Front panel cover and accessory pouch **+$50**
Option 1C—C-5C Camera Option 04 **+$495**
Option 1K—K212 Portable Instrument Cart **+$330**
Option 1R—Rackmount Kit **+$150**
Option 1T—Carrying Case **+$215**
Option 1V—Operators Video Tape (VHS-NTSC) **+$29.95**
Option 23—P6062B 1X/10X probe **+$350**

CONVERSION KIT

Rackmount Adapter—Order 016-0819-00 **$155**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

M1—2 Calibrations. **+$85**
M2—2 Years Service. **+$150**
M3—2 Years Service and 4 Calibrations. **+$290**
M4—5 Calibrations. **+$270**
M5—9 Calibrations +2 Years Service. **+$595**

OPTIONAL ACCESSORIES

Service Manual—Order 070-6299-00 **$25**
Front Panel Cover and Accessory Pouch—Order 020-1514-00 **$60**
Front Panel Cover—Order 200-3397-00 **$5**
Accessory Pouch—Order 016-0677-02 **$45**
Viewing Hoods—
(Collapsible) Order 016-0592-00 **$14.25**
(Polarized) Order 016-0180-00 **$60**
(Binocular) Order 016-0566-00 **$19**
Carry Case—Order 016-0792-01 **$360**
CRT Light Filters—(Clear) Order 337-2775-01 **$1.95**
1107 DC Inverter—See end of this section. **$1,140**
1107 Mounting Kit—See end of this section. Order 016-0785-00 **$55**
1106 Battery Pack—See end of this section. **$1,580**
1105 Power Supply—See end of this section. **$2,090**

RECOMMENDED PROBES

P6062B—Switchable Atten Probe **$175**
P6103—10X Standard Probe **$35**
P6122—10X Miniature Probe **$58**
P6130—10X Subminiature Probe **$130**
P6008—10X Environmental Probe **$250**
P6009—100X High Voltage Probe **$205**
P6015—1000X High Voltage Probe **$725**
P6202A—10X FET Probe **$715**
P6021—Current Probe **$450**
P6022—Current Probe **$495**
1101A—Accessory Power Supply **$435**
A6302—Current Probe **$595**
A6303—Current Probe **$1,120**
AM 503—Current Probe Amplifier **$1,185**
A6901 Ground Isolation Monitor—See Accessories Section. **$680**
A6902B Voltage Isolator—See Accessories Section. **$1,885**

RECOMMENDED CAMERAS

C-5C—Option 04. See Accessories Section. **$495**
C-7—Option 02. See Accessories Section. **$595**

RECOMMENDED CARTS

K212—For on-site mobility. See Accessories Section. **$350**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

Travel Line Package

- **Impact-Resistant Packaging**
- **Impact Protection**
- **Cord Wrap**
- **Pouch and Cover**
- **Carrying Strap**

Now give your 2200 Series instrument the added protection often necessary when used in rough environments. The Travel Line package provides protection from impacts along the front and rear of the instrument. The rear bumper is designed to provide a wider base to set the instrument on and reduces the potential of tip over when standing vertically. The rear also has integrated in it a power cord wrap.

The high-quality rubber moldings offer long life and are resistant to cracking and becoming brittle with age. This composition provides excellent desk/bench and inclined plane grab, so there is no worry about instrument slippage.

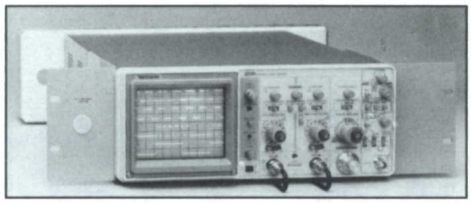
A front panel protective cover and an accessory pouch for carrying probes and documentation is also included, plus a convenient carrying strap for hands free operation and transport.

The Travel Line Package is available for the 2235/2236 and 2220/2230. It can be ordered at the time of purchase or as a field retrofit kit.

ORDERING INFORMATION

Travel Line Package—Order Option 33 for specific instrument.
(2235/2236) Includes rubber molding, accessory pouch, front panel cover, carrying strap. **+$295**
(2220/2221/2230) Includes rubber molding, carrying strap. **+$245**

Travel Line Package Conversion Kits—Includes: Replacement cabinet and rear cover with the rubber moldings installed.
(2213/A, 2215/A, 2235) Order 040-1188-01 **$275**
(2236) Order 040-1187-01 **$135**
(2220/2230) Order 040-1202-01 **$230**



Rackmount Adapter

- **Standard 19-Inch Mount**
- **Rack Depth Extenders**
- **Easy Assembly**
- **Rack Height Only 5.14 Inches**

The low-cost rack adapter provides the means to rackmount any one of the high-performance high-value 2200 Series oscilloscope family. The rackmount is very space efficient, requiring only 5.14 inches of rack height. Rack extenders are provided to allow mounting to virtually any depth rack main frame. A mounting hole is provided for a BNC connector to route the Z-axis input to the front face of the rack. All hardware is supplied for complete mounting into your mainframe.

Kits are available for all 2200 Series products. It can be ordered at any time and is customer installable. For the 2220 and 2230 Digital Storage Oscilloscopes the kit also provides access for the optional GPIB or RS-232C interface connections for automated systems.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	483	19.0
Mount Width	464	18.3
Height	131	5.1
Depth*1	458	18.1
Weight ≈	**kg**	**lb**
Net, Kit	1.5	3.2
Net, Additional to instrument mount	0.7	1.6

*1 *Does not include extenders.*

ORDERING INFORMATION

Rackmount Adapter Kit—Includes: Rackmount depth extenders, all mounting hardware, labels, instruction manual.
(2213/A, 2215/A, 2235) Order 016-0466-00 **$130**
(2235 Opt 01) Order 016-0833-00 **$145**
(2220/2230) Order 016-1003-00 **$130**
(2236) Includes DMM connector Order 016-0015-00 **$290**
(2225) Order 016-0819-00 **$155**

OPTIONAL ACCESSORIES

BNC Female to BNC Female Connector—
Order 103-0070-00 **$6**
50 Ω RF Coaxial Cable—
Order 012-0117-00 **$17**

Shown (from left) are the 1105 Power Supply, the 1106 Battery Pack, and the 1107 DC Inverter.

Portable Power

Tektronix power accessories offer true field-use-portability and operating freedom at service and maintenance sites where conventional ac power sources are not available. They let your scopes go where you need them—and have enough power for your testing and troubleshooting tasks.

The following table outlines the preferred power accessory (or accessory combination) for Tektronix portable oscilloscopes. Note that for many instruments, the 1105 Power Supply is a compatible alternate dc power source.

Instrument	Recommended Power Accessory
2205*1,2213*2, 2213A*1,2215*2, 2215A*1,2221*1,2220*1, 2225*1, 2230*1,2235 Option 01*1, 2235*1,2236*1,2335*1, 2336YA*1,2337*1,2245*1 2246*1,2467,2465A*1, 2465A CT,2465A DV, 2465A DM, 2445A*1	1107/1106 Inverter Battery Pack Combination or 1107 dc Inverter with Auxiliary dc Source
464*3,465B*3, 466*3,475*3,475A*3	1106 Battery Pack or 1105 Power Supply
314,335,336,434,465M, 468*4,485*1	1105 Power Supply

*1 *The 1105 Power Supply is also compatible with these instruments.*

*2 *Some lower serial-numbered units are not compatible for use with the 1107 DC Inverter and the 1105 Power Supply. Neither the 1107 DC Inverter nor the 1105 Power Supply are compatible with the following instruments, unless Option 48 is installed:*
US-built 2213 below Serial Number B020100
US-built 2215 below Serial Number B022000
UK-built 2213 below Serial Number 200239
UK-built 2215 below Serial Number 200307

*3 *These instruments require Option 07 for operation with the 1106 Battery Pack. Field conversion kits are available. Contact your local Tektronix Sales Engineer. But when the 1105 Power Supply is used with these 400 Series instruments, Option 07 is not required.*

*4 *Because of limited instrument operating time available when running from the internal batteries, it is recommended that an external dc power source be used.*

1105 Power Supply

CHARACTERISTICS

ELECTRICAL

Internal Battery Voltage Range—22 to 28 V.
External DC Input Voltage Range—24 to 30 V. (Maximum elevation for the positive and the negative power leads is 60 V with respect to chassis ground.)
Output—Waveform: Square wave. Frequency: 60 Hz ±10%.

Amplitude

DC Power Source	Peak AC Output: Standard Configuration (0.9 A Load)	Peak AC Output: Option 01 Configuration (0.45 A Load)
+22 V Internal		
+24 V External	108 V ±7%	216 V ±7%
+28 V Internal		
+30 V External	138 V ±7%	276 V ±7%

Maximum Recommended Output Current—Standard: 0.9 A. Option 01: 0.45 A.
Minimum Battery Operating Time—50 W hours from full charge.
Battery Charging Time—14 to 16 hours from full discharge at temperatures from 0 to 40°C (+32 to +104°F).
Battery Charging Rate—Full: 600 mA ±10%. With Thermal Cutout Open: 254 mA ±10%.
AC Charging Power Frequency Range—50 to 60 Hz.

AC Charging Voltage Rates

Line Voltage Selection Wiring	AC Voltage Ranges: Standard Configuration	AC Voltage Ranges: Option 01 Configuration
From Factory	100 to 132 V	200 to 264 V
With Internal	90 to 120 V	90 to 120 V
Connection	180 to 240 V	100 to 132 V
Changes	200 to 264 V	180 to 240 V

Maximum Power Consumption From AC Source—40 W.

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to 40°C (32 to 104°F). Nonoperating (with battery installed): −40 to +60°C (−40 to +140°F). Nonoperating (without battery): −55 to +75°C (−67 to +167°F).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	165	6.5
Height	250	9.8
Depth	216	8.5
Weight ≈	**kg**	**lb**
Net	8.8	19.4

ORDERING INFORMATION

1105 Power Supply **$2,090**
Includes: DC power cord, 915 mm (36 in), for external dc input (161 0094-00); instruction manual (070-1479-01).

OPTION

Option 01—230 V ac Operation. **NC**
Includes: 2.1 m (7 ft) IEC power cable (161-0098-00).

1106 Battery Pack

CHARACTERISTICS

ELECTRICAL

DC Power Output—+22 to +24 V for 7 ampere-hours (with maximum current of 5 A).
Minimum Battery Operating Time—75 W hours (from full charge).
Battery Charging Time—14 to 16 hours (from full discharge, at temperatures from 0 to +40°C (+32 to +104°F).
Battery Charging Rate—Full: 620 mA. With Thermal Cutout Open: 60 mA.
AC Charging Power Frequency Range—50 to 400 Hz.
AC Charging Voltage Ranges—Standard: 100 to 132 V; 200 to 264 V. With Internal connection change: 90 to 120 V; 180 to 240 V.
Maximum AC Charging Power Consumption—40 W at 115 V, 60 Hz.

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +40°C (+32 to +104°F) Nonoperating (with battery installed): −40 to +60°C (−40 to +140°F). Nonoperating (without battery): −55 to +75°C (−67 to +167°F).

PHYSICAL CHARACTERISTICS

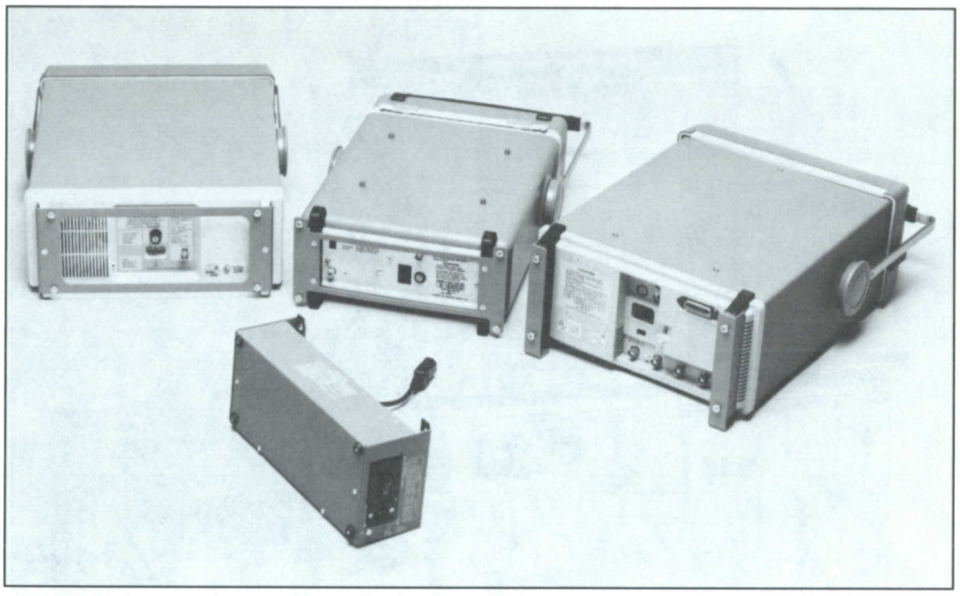
Dimensions	mm	in.
Width, latches in latched position	292	11.5
Height w/feet & latches	66	2.6
Depth	432	17.0
Weight ≈	**kg**	**lb**
Net	7.3	16.0

ORDERING INFORMATION

1106 Battery Pack **$1,580**
Includes: Instruction manual (070-1713-00).
2220—Mounting kit not available
2300—Mounting kit not available
Mounting Kit for 2445A, 2465A, 2467 Oscilloscopes—Order 016-0797-00*1

*1 *Contact your local Sales Office.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.



The 1107 DC Inverter can be quickly attached to or detached from the rear of Tektronix 2000 Series oscilloscopes via easily installed adapter kits. Shown here with adapters installed are (from left) the Tektronix 2236, 2336 and 2465A Oscilloscopes.

1107 DC Inverter

CHARACTERISTICS

ELECTRICAL

Output Frequency—Approximately 60 Hz.
Output Voltage and Timing (+12 V Mode)—Measured with a 200 Ω resistive load (approximately 60 W).

Output Parameter	Output: With +12.3 V DC Input	Output: With +14.2 V DC Input
Peak Voltage	160 V ±10%	160 V ±10%
Table Voltage	130 V ±10%	140 V ±10%
Turn-on Time	6.2 ms ±15%	6.2 ms ±15%
Dead Time	2.2 ms ±15%	2.2 ms ±15%

Output Voltage and Timing (+24 V Mode)—(Measured with a 166 Ω resistive load at ≈100 W).

Output Parameter	Output: With +22.5 V DC Input	Output: With +28.5 V DC Input
Peak Voltage	150 V ±10%	160 V ±10%
Table Voltage	135 V ±10%	150 V ±10%
Turn-on Time	6.2 ms ±15%	6.2 ms ±15%
Dead Time	2.2 ms ±15%	2.2 ms ±15%

Rated Output Power in +12 V Mode—70 W (−15 to +35°C); 50 W (−15 to +55°C). DC source must be 117 V A +11.7 V or greater.
Rated Output Power in +24 V Mode—100 W.
Output Overload Protection—Output disabled and audible tone generated when ac load exceeds 100 W.
Input Voltage Range Selection—Automatic between +12 V mode and +24 V mode.
Operating Inputs—Measured at input of supplied dc power cord.

	DC Volts: +12 V Mode	DC Volts: +24 V Mode
Turn-on Range	+11.7 to 15.9 ±5%	+22.2 to +30.0 ±5%
Battery Protection Shut-down Limit*1	+10.0 ±5%	+21.0 ±5%
Difference Between Minimum Turn-on Range and Battery Protection Shut-down Limit*1	≥1.2	≥0.85

*1 *Tested with a variable dc supply without a load on the output.*

ENVIRONMENTAL

The 1107 DC Inverter meets environmental requirements of MIL-T-28800C for Type III, Class, 3, Style C equipment with humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4 (except Electromagnetic Compatibility).
Ambient Temperature—Operating: −15 to +55°C (+5 to +131°F). Nonoperating: −62 to +85°C (−80 to +185°F).
Altitude—Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 300 m (1,000 ft) above 1500 m (5,000 ft). Nonoperating: To 15 250 m (50,000 ft).
Humidity—Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C para. 4.5.5.1.2.2. for Type III, Class 3 Instruments.
Electromagnetic Compatibility—Meets radiated emission requirements per VDE 0871 Class B, Meets MIL-STD-461B for the following tests: Part 4 (CE01, CE03, and CS02); Part 5 (CS06 and RS02); and Part 7 (CS01, RE02, and RS03). Conducted emissions measurements performed on the dc input power cord.
Vibration—Operating: 15 minutes along each of three major axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 to 55 to 10 Hz in one minute sweeps. Held 10 minutes at 55 Hz in each of the three major axes.

The Tektronix 2465 Oscilloscope with attached 1106 Battery Pack and 1107 DC Inverter becomes a completely independent measurement package—readily transportable to remote sites where conventional ac power sources are not available.

Shock—Operating and Nonoperating: 50 g, ½ sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks

Note: The following 1107 DC Inverter and oscilloscope combinations meet or exceed MIL-T-28800C Class 3 requirements for vibration and shock when attached together with designated mounting hardware:

1107/2445A	1107/1106/2445A
1107/2465A	1107/2335
1107/2455A	1107/2336
1107/1106/2467	1107/2337
1107/1106/2465A	

Transportation Package Vibration—Meets limits of National Safe Transit Association Test Procedure 1A-B-1.
Transportation Package—Drop Meets limits of National Safe Transit Association Test Procedure 1A-B-2 with a 914 mm (36 inch) drop.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	276	10.9
Height	119	4.7
Depth	84	3.3
Weight ≈	**kg**	**lb**
Net	1.6	3.5
Shipping	1.8	4.0

ORDERING INFORMATION

1107 DC Inverter **$1,140**
Includes: 559 mm (22 in), dc power cord (161-0095-00); instruction manual (070-5056-00).

OPTIONAL ACCESSORIES
OSCILLOSCOPE MOUNTING KITS

1106—(2445A, 2465A, and 2467) Order 016-0797-00*1
1107—(2445A and 2465A) Order 016-0783-00*1
1107—(2335, 2336, 2336YA and 2337) Order 016-0786-00 **$50**
1107—(2200 Series) Cannot be used with Travel Line Package. Order 016-0785-00 **$55**
1107—(2235/2236, 2220/2230) Order 016-0785-00 **$55**
Not available for 2245 or 2246.

*1 *Contact your local Sales Office.*

TEKTRONIX IN THE CLASSROOM

To take the guess work out of classroom equipment selection, pages 334 through 340 describe test instruments and other classroom materials that many schools and training facilities, worldwide, are using. Listed below are instruments from the Portable Oscilloscope group and TM 500 Series. These units have been designed to be "student proof" and reliable. You can count on them to withstand the intensive use test equipment receives in the lab, day after day.

EQUIPMENT AND MATERIALS

Lab Stations

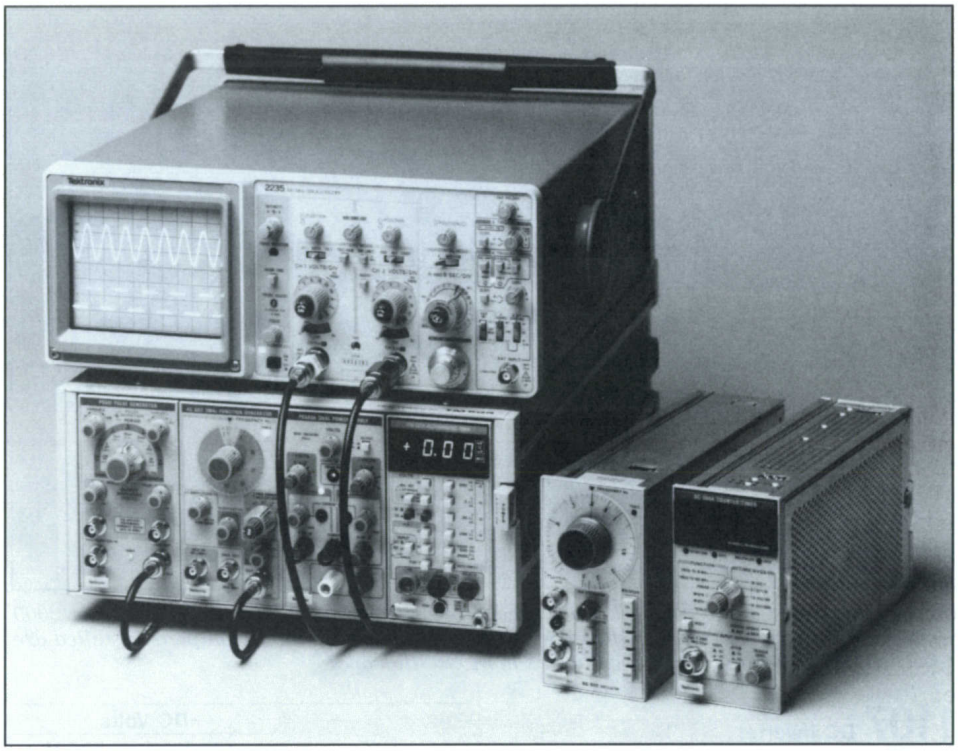
Tektronix is often asked by educators to recommend equipment for teaching electrical and electronic theories and concepts. We have worked with many schools over the years to develop effective lab stations. We suggest the following configurations of test and measurement equipment from the Portable Oscilloscope group and TM 500 Series. For a complete description of the TM 500 and other listed oscilloscopes and equipment refer to Alphanumeric Index.

Warranty/Service

The recommended oscilloscopes come with a three-year warranty. After the warranty period—you can still get replacement parts, when they're needed, because service documentation is complete and accurate. There are also a variety of service options available which can give you years of minimum-cost maintenance. Service is available through your local Tektronix Sales Office. The overall cost of ownership over the life of these instruments is excellent. See Customer Service Section for further information, contact your Tektronix Sales Representative, or call the National Marketing Center at 1-800-426-2200, ext. 99.

Safety

Having safe equipment in the classroom is especially important when there are inexperienced equipment operators. The oscilloscopes recommended for classroom use are listed by UL, CSA (Canada), VDE (Germany) and have been approved for use under the building codes of major municipalities.



Intermediate Lab Station with optional plug-ins.

Products	Beginning Labs	Intermediate Labs	Advanced Labs	Digital Labs*1
2225	✓			
2235 or 2245		✓		
2236 or 2246			✓	
2220 or 2230				✓
CRS2220				✓
CRS2225	✓			
CFG250	✓	✓	✓	✓
CFC250	✓	✓	✓	✓
CPS250	✓	✓	✓	✓
CDM250	✓	✓	✓	✓
TM 503	✓			
TM 504		✓	✓	✓
PS 503A	✓	✓	✓	
FG 503	✓	✓	✓	✓
DM 501A	✓			
DM 502A		✓	✓	✓
PG 501		✓	✓	✓
DC 504A*2		✓	✓	✓
SG 502*2		✓	✓	✓

*1 *The digital storage oscilloscope lab packages provide analog capability as well as storage. The equipment is ideal for students studying slow, non-repetitive signals in mechanical and physical science labs.*

A primer, an "Introduction to Digital Storage" (46-W-6051) can be used to introduce or review digital concepts. It is available from the Tektronix Sales Office.

*2 *Optional.*

TEKTRONIX CLASSROOM SERIES

Educators have told Tektronix that they would like to use simple, easy to learn, industrial quality, safety certified equipment in their classrooms and labs. They say it should be equipment that their students will use when they graduate to jobs in industry. Since most school budgets are limited, industrial quality equipment has not always been affordable, particularly for beginning electronics student labs.

Tektronix has listened to educators and now has a new industrial-quality product series developed especially for beginning electronics students, whether they're in four-year electrical engineering/electronics technology programs or two-year applied science programs, trade/technical schools or secondary schools.

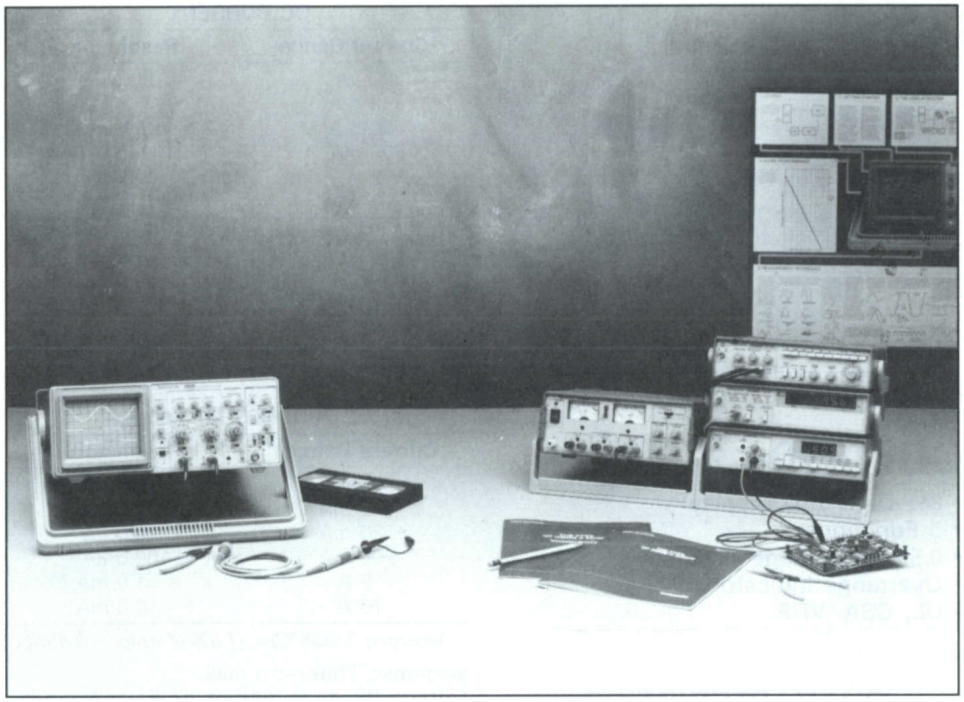
The Classroom Series is affordable and meets the demanding criteria for a school environment, but Tektronix didn't stop there. To support the school's electronics curriculum we also made available manuals, video tapes and other instructional materials that were designed and written by educators, especially for the student.

Tektronix' Classroom Series comprises two lab packages of standalone bench equipment that is UL listed, and approved by CSA, and VDE. DSO Lab 1 includes the 60 MHz 2220 Oscilloscope, CPS250 Triple-Output Power Supply, 2 MHz CFG250 Function Generator, 3-½ digit CDM250 Digital Multimeter, and 100 MHz CFC250 Frequency Counter.

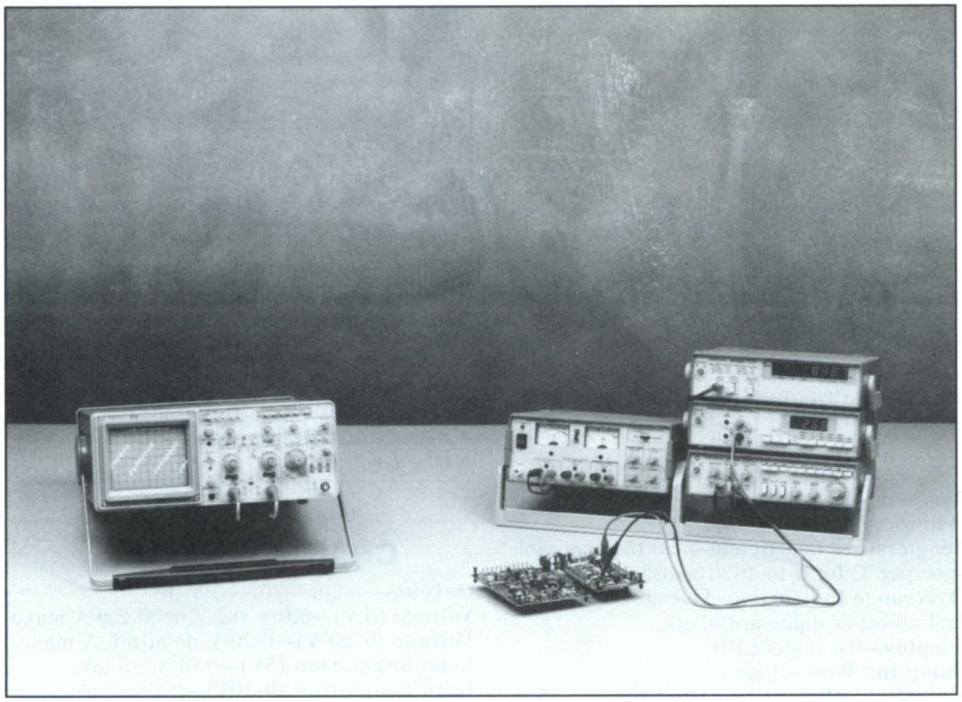
Basic Lab 2, includes the 50-MHz 2225 Oscilloscope, CPS250 Triple-Output Power Supply, 2 MHz CFG250 Function Generator, 3-½ digit CDM250 Digital Multimeter, and the 100 MHz CFC250 Frequency Counter.

Although designed to stand alone, this test and measurement equipment may also be conveniently stacked together to minimize required bench space.

See page 302 and contact your Tektronix Sales Engineer or other Tektronix representative for support materials availability. The National Marketing Center 1-800-426-2200 will also know about new educational materials and instrumentation as they are introduced throughout the year.



CRS 2225 Basic Lab 2.



CRS 2220 DSO Lab 1.

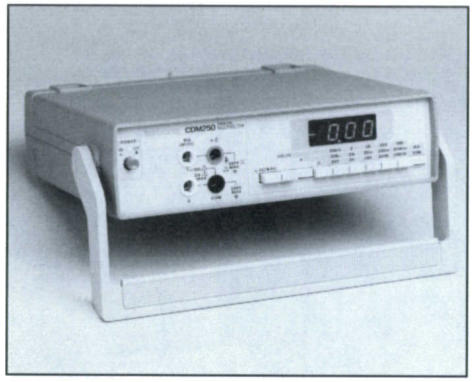
CRS2220 DSO Lab 1	CRS2225 Basic Lab 2
• 2220 60 MHz Oscilloscope	• 2225 50 MHz Oscilloscope
• CPS250 Power Supply	• CPS250 Power Supply
• CFG250 Function Generator	• CFG250 Function Generator
• CDM250 Digital Multimeter	• CDM250 Digital Multimeter
• CFC250 Frequency Counter	• CFC250 Frequency Counter
• Instructional Material	• Instructional Material

ORDERING INFORMATION

CRS2220	**$3,995***
CRS2225	**$2,195***

See individual product listings for option and accessory information.

* *Package prices are available only for qualifying educational institutions. Contact the National Marketing Center at 1-800-426-2200 or your local Tektronix Field Office for more information.*



CDM250

CDM250 Digital Multimeter

- **3½ Digit LED Display**
- **5 Functions**
- **0.5% DC-Voltage Accuracy**
- **Overrange Indicator**
- **UL, CSA, VDE**

CHARACTERISTICS

DC VOLTS

Voltage Range*	Resolution
200 mV	100 μV
2 V	1 mV
20 V	10 mV
200 V	100 mV
500 V	1 V

* *Accuracy (18-28°C)= ± 0.5% of range +1 digit.*

Response Time—3 s maximum.
Input Impedance—10 MΩ.
Maximum Input Voltage—500 V.
Common-Mode Rejection Ratio—>100 dB (50-60 Hz).
Normal-Mode Rejection Ratio—>50 dB (50-60 Hz).
Sampling Rate—2.5/s.

AC VOLTS (45-500 Hz)

Voltage Range*	Resolution
200 mV	100 μV
2 V	1 mV
20 V	10 mV
200 V	100 mV
500 V	1 V

* *Accuracy (18-28°C)= ±1% of range +4 digits.*

Response Time—8 s maximum.
Input Impedance—10 MΩ, <100 pF.
Max Input Voltage—500 V dc or V ac rms.

DC CURRENT

Current Range	Resolution
200 μA*1	0.1 μA
2 mA*1	1.0 μA
20 mA*1	10.0 μA
200 mA*1	100.0 μA
2 A*2	1.0 mA
10 A*2	10.0 mA

*1 *Accuracy (18-28°C)= ±1% of range +1 digit.*
*2 *Accuracy (18-28°C)= ±1% of range +3 digits.*

Response Time—3 s max.
Voltage Burden—200 μA to 200 mA range: 300 mV DC max; 2 or 10 A: 750 mV DC max.
Max Input Current—≤2 A (w/4 A fuse).

AC CURRENT (45-500 Hz)

Current Range*	Resolution
200 μA	0.1 μA
2 mA	1.0 μA
20 mA	10.0 μA
200 mA	100.0 μA
2 A	1.0 mA
10 A	10.0 mA

* *Accuracy (18-28°C)= ±1.5% of range +4 digits.*

Response Time—3 s max.
Voltage Burden—200 μA to 200 mA range: 300 mV RMS max; 2 or 10 A: 750 RMS max.
Max Input Current—≤2 A (w/4 A fuse).

RESISTANCE

Ohms Range	Resolution	Max Test Current
200 Ω*1	0.1 Ω	2.5 μA
2 kΩ*1	1.0 Ω	250.0 μA
20 kΩ*1	10.0 Ω	50.0 μA
200 kΩ*1	100.0 Ω	5.0 μA
2 MΩ*1	1.0 kΩ	500.0 nA
20 MΩ*2	10.0 Ω	50.0 nA

*1 *Accuracy (18-28°C)= ±0.75% of range +4 digits.*
*2 *Accuracy (18-28°C)= ±1.5% of range +5 digits.*

Response Time—20 MΩ: 15 s max; 200 Ω: 5 s max; 200 Ω to 2MΩ: 5s.
Max Common-Mode Voltage—500 V (dc +peak ac).
Max Open-Circuit Voltage—200 Ω: 3.2 V; 2K to 20 MΩ: 0.6 V.

OTHER CHARACTERISTICS

Temperature—Operating: 10 to 40°C. Storage: −10 to +60°C.
Temperature Coefficient—<0.15×applicable spec per°C for 0 to 18°C and 28 to 40°C.
Overrange Indication—Leftmost digit is "1" and all other digits are blank.
Display—3½ digits LED.
Sampling Rate—2.5/s.
Relative Humidity—Operating: 75%. Nonoperating: 80%.
Temperature Coefficient—<0.15×applicable accuracy spec per °C for 10 to 18°C and 28 to 40°C.

POWER REQUIREMENTS

Line-Voltage Ranges—100, 120 V ac; 200, 250 V ac maximum limit.
Line-Frequency Range—50-60 Hz.
Max Power consumption—7.5 V A.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	240	9.45
Height	64	2.52
Depth	190	7.49
Weight ≈	**kg**	**lb**
Net	1.59	3.50

ORDERING INFORMATION

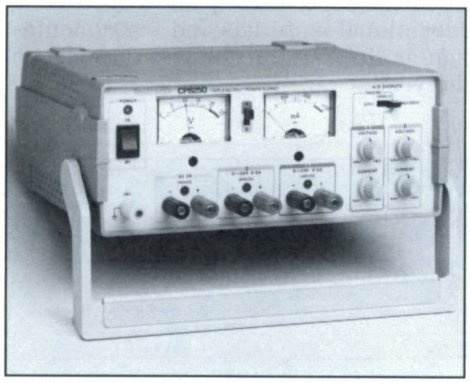
CDM250 Digital Multimeter **$310**
Includes: Power cord, test lead, spare fuse, Operator Manual (070-6736-00).

OPTIONAL ACCESSORY

Service Manual Order 070-6735-00. **$25**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland, 220 V, 50 Hz.



CPS250

CPS250 Power Supply

- **Triple Output**
- **Analog-Type Voltage/Current Meter**
- **Overload Indicator**
- **Independent/Tracking Mode**
- **UL, CSA, VDE**

CHARACTERISTICS

Outputs—0-20, 0-20, +5 V dc.
Voltage (5 V)—5.0 ± 0.1 V dc at 2.0 A max.
Voltage (0-20 V)—0-20 V dc at 0.5 A max.
Load Regulation (5V)—0.01% +5 mV.
Load Regulation (0-20V)—0.1%+3mV.
Line Regulation (5 V)—0.1% +5 mV.
Line Regulation (0-20 V)—0.01% +3 mV.
Ripple/Noise—2 mV RMS (5 Hz-1 MHz).
Tracking Error—±0.2% ±20 mV.
Indicator—Analog-type front-panel meter.
V Range: 0-25 V dc ±2.5% of full scale.
I Range: 0-600 mA ±2.5% of full scale.

POWER REQUIREMENTS

Line-Voltage Ranges—110, 120 V ac ±10%; 200, 250 V ac maximum limit.
Line Frequency—50-60 Hz.
Max Power Consumption—8.5 V A.
Operating Temperature—10 to 40°C.
Storage Temperature—−20 to 60°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	240	9.46
Height	100	3.94
Depth	190	7.49
Weight ≈	**kg**	**lb**
Net	4.77	10.50

ORDERING INFORMATION

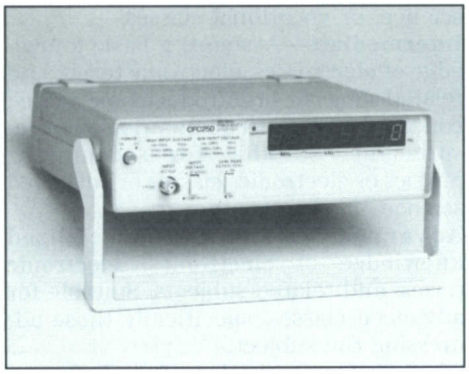
CPS250 Power Supply **$395**
Includes: Test leads, Operator Manual (070-6740-00).

OPTIONAL ACCESSORY

Service Manual Order 070-6739-00. **$25**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland, 220 V, 50 Hz.



CFG250

CFG250 Function Generator

- **Decade Ranges Hz-MHz**
- **Square, Triangle, Sine Waves, TTL Pulses**
- **Low-Distortion, High-Accuracy Outputs**
- **20-dB Attenuator**
- **Internal or External Sweep**
- **UL, CSA, VDE**

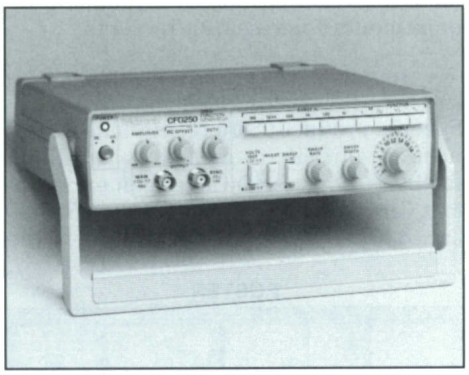
CHARACTERISTICS

The following characteristics/specifications apply to the CFG250 Function Generator after a 1-hour warmup at 23 ±5°C at a relative humidity ≤70%.

Waveform—Sine, square, triangle.
Symmetry—1% to 100 kHz.
Frequency Range—0.2 Hz to 2.0 MHz, 7 decade ranges.
Amplitude—5 mV p-p to 20 V p-p continuously variable (±5% of full scale after 20 min warmup).
DC Offset—−10 to +10 V dc continuously variable.
Output Impedance—50 Ω±10%.
Sine-Wave Distortion—THD 10 Hz to 100 kHz: <1%.
Square-Wave Response—<100 ns.
Triangle Linearity—1% to 100 kHz.
Pulse Output Amplitude—>3 V p-p (open); Rise Time: <100 ns.
Sweep (Internal)—Linear.
Sweep Rate-0.5 Hz (P=2 s) to 50 Hz (P=20 ms) continuously variable.
Sweep Width—Variable 100:1.

POWER REQUIREMENTS

Line Voltage Ranges—100, 120 V ac ±10%; 200, 250 V ac maximum limit.
Line-Frequency Range—50-60 Hz.
Max Power Consumption—16 V A.



CFC250

OTHER CHARACTERISTICS

Operating Temperature—10 to 40°C.
Storage Temperature—−10 to +60°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	240	9.45
Height	64	2.52
Depth	190	7.49
Weight ≈	**kg**	**lb**
Net	1.63	3.60

ORDERING INFORMATION

CFG250 Function Generator **$330**
Includes: power cord, Operator Manual (070-6738-00).

OPTIONAL ACCESSORY

Service Manual Order 070-6737-00. **$25**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland, 220 V, 50 Hz.

CFC250 Frequency Counter

- **5 Hz to 100 MHz**
- **8-Digit LED Display**
- **Overload Indicator**
- **UL, CSA, VDE**

CHARACTERISTICS

Display—Eight-digit 0.43 inch LED readout with automatic decimal point positioning and leading-zero blanking. LED annunciators indicate display overflow.
Frequency Range—AC coupled: 5 Hz to 100 MHz.
Sensitivity—30 mV RMS (5 Hz-30 MHz). 50 mV RMS (30 MHz-70 MHz). 80 mV RMS (70 -100 MHz).
Attenuation—Selectable 1, 1/10 (1X, 10X).
Impedance—1.5 MΩ, paralleled by 40 pF.
Dynamic Range—0.08 to 42 V.
Maximum Input Voltage—42 V peak (5 Hz-100 kHz). 13.8 V peak (100 kHz-10 MHz). 5.4 V peak (10-100 MHz).
Input Connector—BNC.
Resolution—1 Hz.
Accuracy—±1 count ±time base accuracy.
Gate Time—$^1/_6$ second.

TIME BASE

Crystal Frequency (at Calibration)—3.579545 MHz.
Temperature Stability—±10 ppm, 0 to 50°C.
Aging Rate—±10 ppm/year.

POWER REQUIREMENTS

Line Voltage Ranges—100, 120 V ac; 200, 250 V ac maximum limit.
Line Frequency Range—50-60 Hz.
Maximum Power Consumption—≈9 V A.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	240	9.45
Height	64	2.52
Depth	190	7.49
Weight	**kg**	**lb**
Net	1.48	3.25

OTHER CHARACTERISTICS

Operating Temperature—10 to 40°C.
Storage Temperature—−10 to +60°C.
Relative Humidity—0-80%.

ORDERING INFORMATION

CFC250 Counter **$295**
Includes: Power cord, Operator Manual, (070-6742-00).

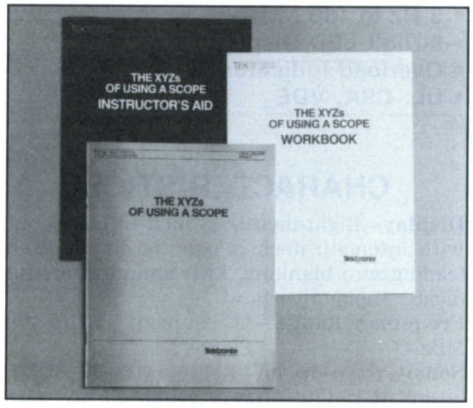
OPTIONAL ACCESSORY

Service Manual Order 070-6741-00. **$25**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland, 220 V, 50 Hz.

OSCILLOSCOPE ORIENTATION PACKAGE



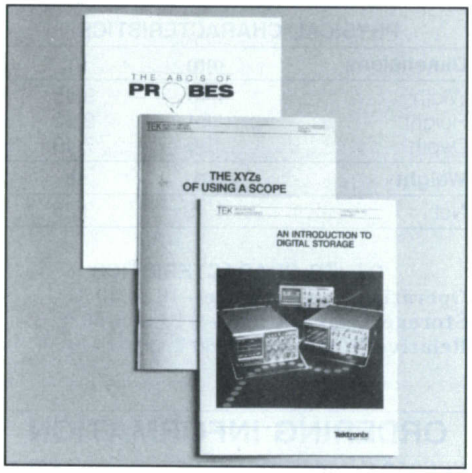
XYZs Primer set for quantity purchases.

For basic analog oscilloscope orientation, we recommend the following equipment. This equipment can also be used as part of the lab stations for beginning and intermediate electrical, electronics, and physics lab courses.

- Oscilloscope (2225, 2235, or 2245)
- Basic Training Lab, CRS101 (includes CRS10 Power Unit, plus the CRS30 General Purpose Board)
- Primer, XYZs of Oscilloscopes (quantity package 062-9322-00 or 062-6731-00)
- Video Tape, 2200 Series Operation (068-0146-xx or 068-0227-xx)
- Poster (46-TTA-528)

See the video tapes listed on the next page for supplementary oscilloscope programs for beginning students.

PRIMERS



Shown above: ABCs of Probes, XYZs of Scopes, An Introduction to Digtal Storage.

Single complimentary copies are available from your local Tektronix Sales Office.
An Introduction to Digital Storage—Request 46-W-6051.
The ABCs of Probes—Request 60-W-6053.
XYZs of Using an Oscilloscope (2215A version)—Request 46-AX-4758-2.
(Instructor's Aid)—Request 46-W-5169-2.
(Workbook)—Request 46-W-5170-2.
XYZs of Using an Oscilloscope (2225 version)—
(Instructor's Aid)—Request 46-W-6466.
(Workbook)—Request 46-W-6465.
(Primer)—Request 46-W-6428.
(Poster)—Request 46-W-6430.
XYZs of Using an Oscilloscope, Quantity Package—Includes: 50 primers; one instructor's aid, and one student workbook. (The student workbook may be reproduced for educational use without permission from Tektronix.) 2225: Order 062-9322-00, 2215A: Order 062-6731-00.

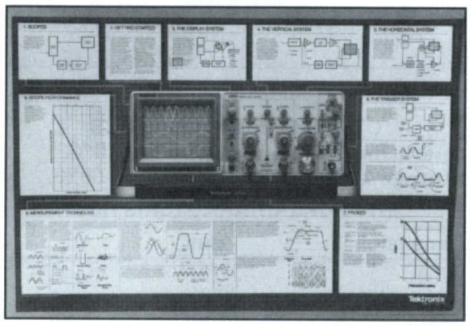
GRADUATE CLASSES AND RESEARCH

Your Tektronix Sales Representative can consult with you about recommendations for advanced classes in special technical areas, or to discuss special equipment requirements for research projects.

SPECIFIC TEKTRONIX PRODUCT TRAINING

Specific product training seminars can be held at your site or at nearby Tektronix facilities. For specific arrangements contact Customer Training at 1-800-835-9433 ext. 430

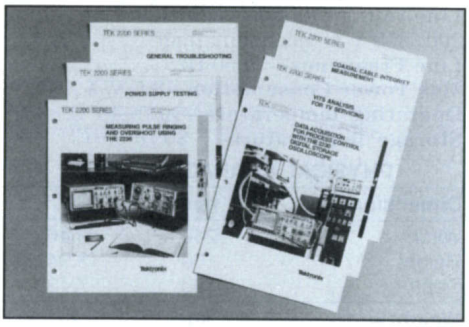
POSTER



This full-color poster (2×3 ft) shows a 2225 oscilloscope front panel with call-outs of functions.

The poster (46-TTA-528) follows the XYZs of Oscilloscopes primer format. Complimentary copies are available from your local Tektronix Sales Office.

APPLICATION NOTES



Application Notes are available for many basic measurement concepts. New Application Notes are available throughout the year. Check with your local Tektronix Sales Engineer or call the National Marketing Center for new or existing complimentary copies.

VIDEO TAPES

The following list of video tapes is rated for beginning, intermediate, or advanced students.
Beginning—Assumes little knowledge of electronics, electronic terms, or related subjects. A beginning audience would be beginning physics, electronics, general science, or vocational classes.
Intermediate—Assumes a basic knowledge of electronics, electronic terms, and related subjects, or introduces specialized concepts, such as frequency-domain measurement. Suitable for second-year physics or electronics classes or advanced science classes.
Advanced—Assumes a specialized knowledge of electronics, electronic terms, and related subjects. Suitable for advanced classes, specifically those addressing the subject.
2200 Series Operation, Part I (Beginning)—Addresses operation of the 2213 and 2215 Portable Oscilloscopes. Follows the format of the *XYZs of Oscilloscopes* primer. (26 min).
2200 Series Operation, Part II (Intermediate)—Covers operation of the 2235 and 2236 Oscilloscopes. Covers the differences and additional features of the 2235 over the 2213. Additional features of the 2235 are demonstrated in detail using typical analog and digital waveforms (18 min).
2225 Oscilloscope Primer—Practical scope measurements with the 2225 (Beginning)—covers operation of the 2225 using many applications as operation illustrations (32 min.).

2245/2246 GPS Operation (1986, Intermediate)—Front-panel controls and typical applications using those controls are demonstrated. Advanced features section makes use of signals from the CRS101 Basic Training Lab. 22 min).

Boolean Logic, A Lighthearted Look At (1983, Intermediate)—The logical relationship, between sets (AND, OR, NOT) is developed in a nontechnical fashion using mimes (8 min).

Color Video Concepts (1979, Advanced)—Explains basic principles of color television. Describes and illustrates relevant characteristics of human vision, light colorimetry. Explains primary and complementary colors. Describes and illustrates camera operation, receiver operation, color cathode-ray tubes. Demonstrates vectorscope operation (38 min).

Monochrome Video Concepts (1981, Intermediate)—Explains and graphically demonstrates concepts of monochrome video transmission and reception (30 min).

Ink Jet Copier Concepts (1983, Beginning)—Provides an overview of operation of ink jet color graphics copiers. Discusses subtractive color and presents the functional parts of the copier system and how they interrelate (10 min).

Fundamentals of Oscilloscopes: A Functional Overview (1986, Intermediate)—Designed for students with prior electronics knowledge and/or some familiarity with oscilloscopes. Functional blocks and their relation to front-panel controls are graphically illustrated in four parts: Overview, Vertical Section, Horizontal Section, and Cathode Ray Tube (15 min).

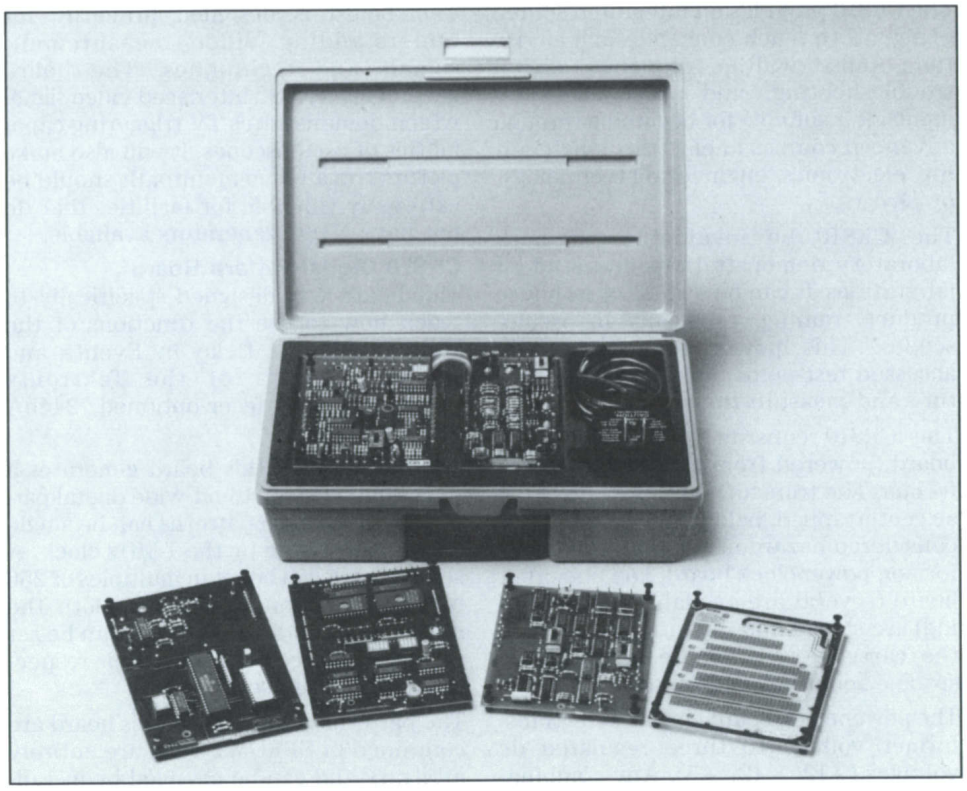
Oscillo-What? What Is An Oscilloscope (1986, Beginning)—Explains what an analog oscilloscope does, how and where it is used. Introduces digitizing oscilloscopes (18 min).

Spectrum Analyzer Concepts (Intermediate)—Contrasts time domain and frequency domain frames of reference. Describes effects of spectrum analyzer construction on performance. Defines terms associated with spectrum analysis. Demonstrates typical applications (12 min).

AM Measurement (1978, Advanced)—Explains basic amplitude modulation parameters. Contrasts time-domain and frequency-domain measurement techniques. Discusses essential formulas and calculations. Demonstrates measurements (9 min).

FM Measurement (1979, Advanced)—Examines basic frequency-modulation parameters, their appearance in the frequency domain, and their measurement with a spectrum analyzer (10 min).

TRAINING LABS



CRS101 and CRS50, CRS70, CRS72, CRS90 signal boards.

Pulsed RF Measurement (1979, Advanced)—Investigates basic pulsed radio-frequency characteristics and their measurement in both time and frequency domains (10 min).

Operating the 2230 Digital Storage Oscilloscope (1986, Intermediate)—2230 operation is demonstrated by showing front-panel controls and each measurement mode using typical analog and digital signals (35 min).

Probe and Signal Concepts (Intermediate)—A video tape and 40-page booklet describes practical uses of passive and current probes. Emphasis is on selecting the correct probe for your application.

ORDERING INFORMATION

Video tapes are available in ¾ inch U-MATIC, Beta, or VHS. Order any tape as follows:

068-xxxx-00—¾ inch U-MATIC.
068-xxxx-01—Beta.
068-xxxx-02—Beta II.
068-xxxx-03—Beta III.
068-xxxx-04—VHS.

2200 Series Operation—
(Part I) Order 068-0146-xx $60
(Part II) Order 068-0151-xx $60

2225 Oscilloscope Primer—
Order 068-0227-xx $60

2245/2246 GPS Operation—
Order 068-0224-xx $60

Boolean Logic, A Lighthearted Look At—Order 068-0199-xx $60

Video Concepts—
(Color) Order 068-0101-xx $260
(Monochrome) Order 068-0128-xx $260

Ink Jet Copier Concepts—
(English) 068-0158-xx $200
(English/German) 068-0174-xx $175

Fundamentals of Oscilloscopes: A Functional Overview—Order 068-0217-xx $60

Oscillo-What? What is an Oscilloscope?—Order 068-0218-xx $60

Spectrum Analyzer Concepts—Order 068-0070-xx $200

Probe & Signal Concepts—Order 068-0229-xx $75

AM/FM/Pulsed RF Measurements—
(AM) Order 068-0072-xx $200
(FM) Order 068-0089-xx $200
(Pulsed RF) Order 068-0097-xx $200

Operating the 2230 Digital Storage Oscilloscope—Order 068-0209-xx $60

Video Sampler—A video sampler containing previews of six education video tape programs on using oscilloscopes and test and measurement concepts to help in your selection. Call the National Marketing Center at 1-800-426-2200 ext 99 and request 40-W-6468. NC

Quotes for quantity purchases of one title are available from the Tektronix National Marketing Center, 1-800-426-2200. In Oregon, call collect 627-9000, ext. 99.

A complete list of video programs is available from Tektronix TV/Media Services 1-503-627-1586.

CRS10 Power Unit

The CRS10 provides an integrated source of signals to teach concepts such as rise time, pulse width, frequency, digital troubleshooting, and video measurements. It is suitable for beginning through advanced courses in electrical engineering, electronics, engineering technology, or physics.

The CRS10 be invaluable for both laboratory demonstrations and student lab stations. It can be useful for in-house product training, especially in oscilloscopes. This power unit has easily accessed test-point pins to reliably capture and measure the signals.

The CRS10 consists of a power/clock board, powered from an external transformer. The transformer*[1] provides 24 V ac centertapped, below the voltage levels considered hazardous by U.L. The transformer, power/clock board, and one other board (several are available, see following) are stored and operated in a tray in the carrying case. There is additional storage room below the tray.

The power/clock board converts the transformer voltage to three regulated dc voltages (+12, −12, +5). Any combination of these voltages is used to power a signal board. The power section also provides a number of line-related power-supply signals for observation.

The clock section provides three fixed crystal-controlled digital signals (10 MHz, 5 MHz, 1 MHz) and a variable-rate triangular waveform. All clock and power signals are connected to the signal board through a 10-pin "harmonica" connector and jumper cable.

CRS30 General-Purpose Board

This board is designed to exercise most oscilloscope functions by providing a variety of digital and analog signals.

Digital signals are available at ECL, TTL, and CMOS levels. Digital signals include logic, a variable pulse train, a low-frequency square wave, a variable stairstep generator (D to A converter), and fast trigger pulses.

Analog signals include a sine wave with glitch; a voltage-to-frequency converter; a waveform whose frequency, amplitude, and slope are set by one control; and a low-frequency triangle. All signals are brought out to probe test points around the board edge.

CRS50 Video-Signal Board

This board is designed primarily for understanding video measurement signals and techniques. The board generates an NTSC interlaced video signal which demonstrates TV triggering capabilities of oscilloscopes. It will also make pictures on a video monitor. It should be extremely valuable for facilities that do not have NTSC generators available.

CRS70 Digital-Pattern Board

This board was designed specifically to teach how to use the functions of the Word Recognizer, Delay by Events, and Boolean Trigger of the Tektronix Counter/Timer/Trigger-optioned 2445A and 2465A.

The circuitry on this board generates a repeating series of 16-bit-wide digital pattern words. These patterns can be single stepped or driven by the 1-MHz clock. A series length can be set in multiples of 256 bits to a maximum of 4096. Both the starting and ending addresses can be set in 256-bit increments from their respective ends of the series.

The patterns generated on this board are contained in EPROMs. They are entirely arbitrary and can be changed by installing a different set of EPROMs. An additional circuit provides a variable glitch at a 1-kHz rate. It is useful in demonstrating glitch-capture features of advanced digital oscilloscopes.

CRS72 Digital-Fault Board

The Digital-Fault Board was designed as a demonstration aid for the 2467 Oscilloscope, which has a microchannel-plate CRT. Most oscilloscopes will not be able to display the signal faults found on this board. It will be helpful primarily for teaching measurement techniques such as fast transients in high repetition rate signals when advanced oscilloscopes such as the Tektronix 2467 are available.

The board induces timing errors in its circuits. These errors replicate timing errors that can be found in real-life situations, but in a more repeatable form. The types of errors include noise and timing-margin violations, clock corruption, and faulty state transitions.

The six separate circuits on this board are both ECL and TTL.

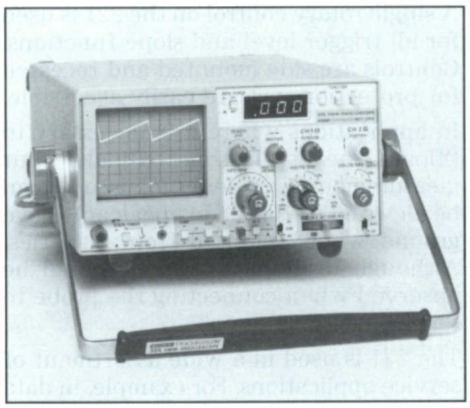
CRS90 Builder's Board

The Builder's Board has a grid pattern of holes, and access to the power supply and signals provided by the power/clock board. It gives the student a simple method of building circuits. This board is useful in labs where soldering skills are taught as part of basic circuit building and measurement course.

ORDERING INFORMATION

CRS101—Basic Training Lab	**$385**
Includes: CRS10 Power Unit; CRS30 General Purpose Board; manual.	
CRS10 Power Unit*[1]	**$255**
Includes: Instruction manual. Each of the following boards require a CRS10 Power Unit for operation.	
CRS30 General Purpose Board	**$200**
CRS50 Video Signal Board	**$115**
CRS70 Digital Pattern Board	**$180**
CRS72 Digital Fault Board	**$225**
CRS90 Builder's Board	**$135**
Instruction Manual— Order 070-5391-00	**$25**

*[1] *For information about international transformer availability for the CRS10, contact your Tektronix Sales Representative.*



305

- **5 MHz at 5 mV/Div**
- **Dual Trace/DMM**
- **Internal Battery Pack**
- **Full X-Y**
- **Weighs ≈10.6 lb**

TYPICAL APPLICATIONS

Electromechanical Measurements
Medical Electronics Maintenance
Automotive/Motor Vehicle

The 305 DMM/Oscilloscope is the ideal oscilloscope for those who demand portability and multifunction versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5-MHz oscilloscope with a precise integral autoranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls, or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5-MHz oscilloscope with a large 8×10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6-lb (4.8 kg), 4.4×9.3×14.6-inch (11.2×23.6 ×37.1 cm) package. The front-panel TTL marker presets the trigger generator for optimum level control on TTL signals.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth—DC to at least 5 MHz. For ac coupling, the lower 3 dB point is ≈10 Hz.
Deflection Factor—5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0 to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.
Display Modes—CH 1, CH 2, Chopped, Alternate, Added, Invert CH 2, and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.
Input R & C—1 MΩ ±2%, paralleled by ≈47 pF.
Maximum Input Voltage—AC or dc coupled, 250 V (dc+peak ac), or 250 V p-p at <1 kHz.

HORIZONTAL SYSTEM

Time Base—500 ms/div to 1 μs/div (1-2-5 sequence). X10 magnifier extends sweep rate to 0.1 μs/div.
Variable Time Control—Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

Time Base Accuracy*1

	0 to +40°C	−15 to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

*1 *Center 8 divisions (excludes first 10 divisions and all sweep past 90 divisions in X10 magnifier).*

TRIGGERING

Modes—Normal and Auto (p-p).
TTL Triggering—TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V, and 0.2 V/div or external trigger signals.
Trigger Sources—Internal CH 1, internal CH 2, external. TTL Threshold voltage, internal (with 10X probe) 1.4 V within ±0.3 V, External (with 10X probe) 1.4 V within ±0.2 V.

Trigger Sensitivity in Normal Mode

Coupling	To 0.5 MHz	At 5 MHz
DC Internal	0.3 div	0.75 div
DC External	15 mV	50 mV
AC	Requirements increase below 60 Hz	

P-P Auto Operation Sensitivity

Coupling	500 Hz to 0.5 MHz	0.5 to 5 MHz
DC, AC Internal	0.5 div	1.0 div
DC, AC External	35 mV	70 mV

External Trigger—Maximum Input Voltage: 250 V (dc+peak ac) at 1 kHz or less (same as vertical). Input R and C: ≈1 MΩ paralleled by ≈47 pF.

X-Y OPERATION

Input—X-axis input is via the CH 1 connector; Y-axis input is via the CH 2 connector.
X-Y Characteristics—Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0 to +40°C over the center 8 div.
X-Axis Bandwidth—DC to 150 kHz.

CRT AND DISPLAY FEATURES

CRT—8×10 div (0.632 cm/div) display. Accelerating potential is 2 kV. GH (P31) phosphor standard.
Graticule—Internal, nonilluminated.

DMM
DC VOLTAGE

Ranges—2, 20, 200, and 1000 V (autoranging).
Accuracy—Within 0.1% of reading, ±2 counts.
Common-Mode Rejection—>100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.
Normal-Mode Rejection—>30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.
Response—<1 s plus range step time (<1 s/step).
Input R—10 MΩ ±2%.
Maximum Input Voltage—±1000 V (dc+peak ac) between HI and LO inputs or between HI and chassis. ±500 (dc+peak ac) between LO and chassis (LO Floating Voltage).

AC VOLTAGE

Ranges—2, 20, 200, and 700 V (autoranging).
Accuracy—Within 0.5% of reading, ±10 counts, 40 to 500 Hz.
Response Time—<5 s plus range step time (<1 s/step).
Input Impedance—10 MΩ paralled by ≈70 pF.
Maximum Input Voltage—700 V RMS if sinusoidal. ±1000 V (dc+peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs. ±500 V (dc+peak ac) between LO and chassis (LO Floating Voltage).

RESISTANCE

Ranges—2, 20, 200, and 2000 kΩ.
Accuracy—Within 0.6% of reading ±3 counts.
Response Time—<5 s plus range step time (<1 s/step).
Maximum Input Voltage—±100 V (dc+peak ac) between HI and LO inputs. 500 V (dc+peak ac) between LO and chassis (LO Floating Voltage).

OTHER CHARACTERISTICS

Amplitude Calibrator—0.3 V, accurate ±1% from 20 to 30°C, ±2% from −15 to +55°C.

POWER REQUIREMENTS

Line-Voltage Range—90 to 132 V ac or 180 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—17 W.
External DC Source—+9 to +32 V.
Charge Time—At least 16 hours for full charge.
Operating Time—Internal NiCad batteries provide ≈1.6 hours of scope and DMM operation, 10 hours of DMM-alone operation, or two hours of scope-alone operation at maximum trace intensity and 20 to 25°C operating temperature.

ENVIRONMENTAL

Ambient Temperature—Operating: −15 to +55°C (Oscilloscope), 0 to +55°C (DMM). Nonoperating: −25 to +75°C.
Altitude—Operating: To 9000 m (30,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5,000 to 30,000 ft. Nonoperating: To 15 000 m (50,000 ft) maximum.
Vibration—15 minutes along each of the 3 major axes, 0.025 in. (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Humidity—Nonoperating: 5 cycles (120 hours) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25, ±5°C and 20 to 80% relative humidity.
Shock—Operating and Nonoperating: 30 g's, ½ sine, 11-ms duration. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width, w/handle	236	9.3
Height	112	4.4
Depth, handle not extended	371	14.6
Depth, handle extended	458	18.0
Weight ≈	**kg**	**lb**
Net, w/o accessories	4.8	10.6
Shipping	7.8	17.1

ORDERING INFORMATION

305 DMM/Oscilloscope **$3,060**
Includes: Two P6149A 10X probes; carrying case (016-0401-00); carrying case cover (200-2260-00); carrying strap assembly (346-0131-02); DMM probe package; clear CRT filter (331-0394 01); blue CRT filter (378-2016-01); external dc cable assembly (012 0406-00); service manual (070-2423-01); operator manual (070-2424-00).

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

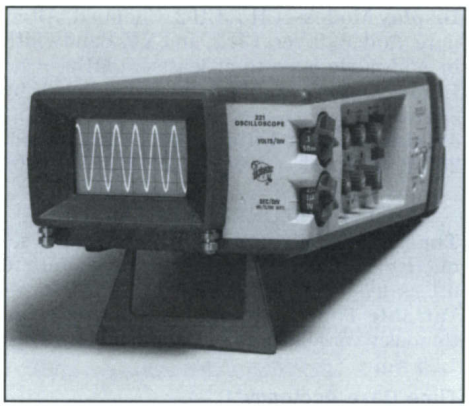
Viewing Hood—Order 016-0297-00 **$2.10**
Adapter Connector—BNC to binding post. Order 103-0033-00 **$6.25**

RECOMMENDED CAMERA

C-30BP Option 01—General purpose camera. See Camera section. **$1,548**
Camera Adapter—Required to mount the C-30BP Camera to the 305. Order 016-0327-01 **$175**

RECOMMENDED CART

K212 Portable Instrument Cart—For on-site mobility. See Accessories section. **$350**



221

- **5 MHz, 5 mV/Div to 100 V/Div**
- **0.1 μs/Div Sweep Rate With X10 Sweep Magnifier**
- **Internal Battery Pack**
- **Integral 1 MΩ Probe**
- **Weighs ≈1.6 kg (3.5 lb)**

TYPICAL APPLICATIONS

Communication Equipment Service
Electromechanical Measurements
Industrial Plant Maintenance

See page 302 for available Application Notes.

The 221 Miniscope weighs just 3.5 pounds and measures only 3×5.2×9 inches. It easily fits into a tool box or brief case, yet has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5-MHz bandwidth, 5-mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least two hours operation away from external power sources. The 221 will operate and charge from practically all the world's principal line voltages: 90 to 250 V, 48 to 62 Hz ac, or 80 to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading, and because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc+peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed-loop servo system that controls blade angle, depth of cut, and machine direction.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth (−3 dB point)—DC to 5 MHz at all calibrated deflection factors. Lower −3 dB point ac coupled is ≈2 Hz.
Deflection Factor—5 mV/div to 100 V/div, accurate ±3% from 0 to +40°C and ±5% from −15 to 0°C and +40 to +55°C. Uncalibrated; Continuously variable between steps to at least 300 V/div.
Input R and C—≈1 MΩ paralleled by ≈29 pF via attached signal-acquisition probe.
Maximum Input Voltage—600 V (dc+peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL SYSTEM

Time Base—1 μs/div to 200 ms/div, accurate ±3%.
Magnifier—Increases all sweep speeds X10 with a maximum sweep speed of 0.1 μs/div.
Variable Time Control—Extends minimum sweep rate to ≈0.5 s/div. Continuously variable between calibrated settings.

TRIGGERING

Modes—Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity

Source	To 1 MHz	At 5 MHz
Internal	0.5 div	1 div
External	0.5 V	1 V

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

X-Y OPERATION

Input—X-axis input is via the external trigger or the external horizontal input.
X-Axis Deflection Factor—1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.
Maximum External Horizontal Input Voltage—200 V (dc+peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.
Input Impedance—≈0.5 MΩ paralleled by ≈30 pF.

CRT AND DISPLAY FEATURES

CRT—6×10 div (0.52 cm/div) display. Accelerating potential: 1 kV. Standard phosphor: GH (P31).
Graticule—Internal, black line, nonilluminated.

OTHER CHARACTERISTICS

Insulation Voltage—500 V RMS or 700 V (dc+peak ac) when operated from internal batteries, with the line cord stored and the plug protected (when operated from an external line, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line + (dc+peak ac) not to exceed 350 V).
Power Sources—Internal NiCad batteries provide at least 2 hours operation at maximum trace intensity for a charging and operating temperature between +20 and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. DC operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended time charges will not damage the batteries. An expanded-scale battery meter indicates full, low, and recharge.

POWER REQUIREMENTS

Line-Voltage Range—90 to 250 V ac or 80 to 250 V dc.
Line Frequency—48 to 62 Hz.
Maximum Power Consumption—5 W.

ENVIRONMENTAL

Ambient Temperature—Operating (Battery only): −15 to +55°C. Charging or Operating from AC Line: 0 to +40°C. Nonoperating: −40 to +60°C.
Altitude—Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles. Held for 3 minutes at 55 Hz.
Humidity—5 days at +50°C, 95% humidity.
Shock—Operating and Nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

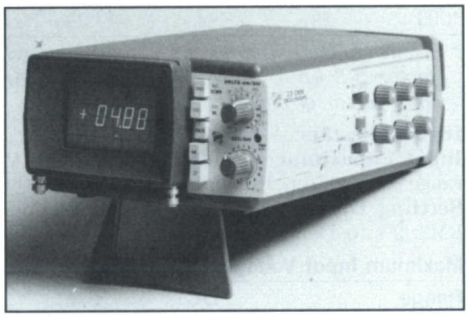
Dimensions	mm	in.
Width	133	5.2
Height	76	3.0
Depth	228	9.0
Weight ≈	**kg**	**lb**
Net, w/o accesssories	1.6	3.5
Shipping	3.6	8.0

ORDERING INFORMATION

221—Oscilloscope **$2,715**
Includes: Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); two spare fuses (159-0080-00); service manual (070-1573-01); operator manual (070-1572-00).

OPTIONAL ACCESSORIES

Alligator Clip Kit—A pair of alligator clips that allow connecting the probe and ground lead to large (up to 3/8 inch) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01). Order 015-0231-00 **$26**
Probe Tips—(To BNC Panel Connector Adapter) Order 013-0084-01 **$13.75**
(To BNC Cable Adapter) Order 103-0096-00 **$13.75**
Power Cable Adapter Assembly—A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$9.25**



213

- **1 MHz at 20 mV/Div**
- **0.4 μs/Div Sweep Rate With X5 Sweep Magnifier**
- **DMM and Miniscope in One Unit**
- **Rugged Construction**
- **Internal Battery Pack**
- **Compact, Weighs ≈1.7 kg (3.7 lb)**
- **True RMS Voltage & Current Measurements**

TYPICAL APPLICATIONS

Power Equipment Measurements
Medical Electronics Maintenance
Industrial Control Systems

The 213 combines a precision 3½-digit digital multimeter and a 1-MHz oscilloscope in one instrument. It is a compact (3×5.2×8.9 inches) and lightweight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the lightweight 213 can be hand held, rested on the equipment being tested, or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc+peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

CHARACTERISTICS

VERTICAL SYSTEM (VOLTAGE)

Bandwidth—DC to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. DC to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is ≈1 Hz.
Deflection Factor—5 mV/div to 100 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 V/div.
Input R and C—10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Maximum Input Voltage

Input Condition	Maximum Input Voltage
DC coupled, 5 mV/div to 1 V/div	500 V (dc+peak ac) at 1 MHz or less
AC coupled, 5 mV/div to 1 V/div	800 V (dc+peak ac) 500 V peak ac component
AC, DC coupled, 2 V/div to 100 V/div	800 V (dc+peak ac) at 1 MHz or less

VERTICAL SYSTEM (CURRENT)

Bandwidth—DC to at least 400 kHz (−3 dB point) for 20 μA/div through 100 mA/div deflection factors. DC to at least 200 kHz (−3 dB point) for 5 and 10 μA/div.
Deflection Factor—5 μA/div to 100 mA/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 mA/div.
Maximum Input Current—2 A RMS or 3 A peak for any range (fuse and diode protection).

HORIZONTAL SYSTEM

Time Base—2 μs/div to 500 ms/div (1-2-5 sequence). Accuracy: ±5%.
Variable Magnifier—Increases all sweep speeds to at least X5 with a maximum sweep speed of 0.4 μs/div.

TRIGGERING

Modes—Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).
Trigger Sensitivity and Coupling—AC Internal: (Auto and Normal 1 MHz) 0.5 div. DC External: 1 MHz, 1 V.

CRT AND DISPLAY FEATURES

CRT—6×10 div (0.52 cm/div) display. GY (P43) phosphor.
Graticule—Internal, black line, nonilluminated.

OTHER CHARACTERISTICS

Insulation Voltage—500 V RMS or 700 V (dc+peak ac) when operated from internal batteries with line cord and plug stored (when operated from ac, line voltage plus floating voltage not to exceed 250 V RMS or 1.4X line + (dc+peak ac) not to exceed 350 V).
Power Sources—Internal NiCad batteries provide three to five hours operation at maximum trace intensity for a charging and operating temperature between +20 and +30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. DC operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge ≈16 hours.

POWER REQUIREMENTS

Line-Voltage Range—90 to 136 V ac. Option 01 is 180 to 250 V ac.
Line Frequency—48 to 62 Hz.
Maximum Power Consumption—8 W.

ENVIRONMENTAL

Ambient Temperature—Operating (Battery Only): −15 to +55°C. Charging or Operating from AC Line: 0 to +40°C. Nonoperating: −40 to +60°C.
Altitude—Operating: To 7500 m (25,000 ft), decrease maximum temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 12 500 m (40,000 ft).
Vibration—Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in.) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles. Held for 3 minutes at 55 Hz.
Humidity—+40°C or less, 80% or less relative humidity.
Shock—Operating and Nonoperating: 150 g's, ½ sine, 2-ms duration in each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	133	5.2
Height	76	3.0
Depth	226	8.9
Weight ≈	**kg**	**lb**
Net (w/o accessories)	1.7	3.7
Shipping	3.9	8.6

DMM

Provides true RMS readings of voltage and current.

DC AND AC VOLTAGE

Range—0.1 to 1000 V full scale in five ranges.
Resolution—100 μV at 0.1 V full scale.
Accuracy in DC Mode—For +25 ±5°C.

Range*1

0.1 V	±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading +0.04% of full scale)/°C
1 V	±0.1% of reading ±1 count. Temp coef is (±0.01% of reading +0.01% of full scale)/°C
10 and 100 V	±0.15% of reading ±1 count. Temp coef is (±0.015% of reading +0.01% of full scale)/°C
1000 V	±0.2% of reading ±1 count. Temp coef is (±0.02% of reading +0.01% of full scale)/°C

*1 *Full scale.*

Accuracy in RMS Mode—For 25 ±5°C. Temperature coefficient (±0.05% of reading +0.1% of full scale)/°C.

Range	Within % of reading shown ±5 counts*1		
	DC	40 Hz to 4 kHz	4 to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1, 10, & 100 V	2%	1%	1%
1000 V	2%	1%	2%

*1 *Accuracy limit increases linearly for crest factor >2 up to twice indicated limit for crest factor of five.*

Input Resistance—10 MΩ.
Input Capacitance—150 pF on 0.1 to 10 V ranges, 100 pF on 100 and 1000 V ranges.
Settling Time—DC: 1.5 s to 0.1% of reading. RMS: 2 s to 1% of reading.

Maximum Input Voltage

Range	DC	AC
0.1 to 10 V	500 V*1	800 V*1
100 to 1000 V	800 V*1	

*1 *DC +peak ac.*

DC AND AC CURRENT

Range—0.1 to 1000 mA full scale in five ranges.
Resolution—100 nA at 0.1 mA full scale.
Accuracy in DC Mode—For +25 ±5°C.
Temperature Coef—(±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 to 1000 mA ±0.25% ±3 counts.

Accuracy in AC Mode

Range	(Within % of reading shown ±5 counts*1)		
	DC	40 Hz to 4 kHz	4 to 40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 to 1000 mA	2.5%	1.5%	3.5%

*1 *Accuracy limit increases linearly for crest factor >2 up to twice the indicated limit for crest factor of five.*

Settling Time—1.5 s to 0.1% of reading.
Maximum Input Current—2 A RMS or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges—1 kΩ to 10 MΩ full scale in five ranges.
Resolution—1 Ω on 1 kΩ scale.

Accuracy—For 25 ±5°C

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 kΩ to 1 MΩ	0.5% ±1 count
10 MΩ	1% ±1 count

Settling Time—2 s ±2 counts.

READOUT

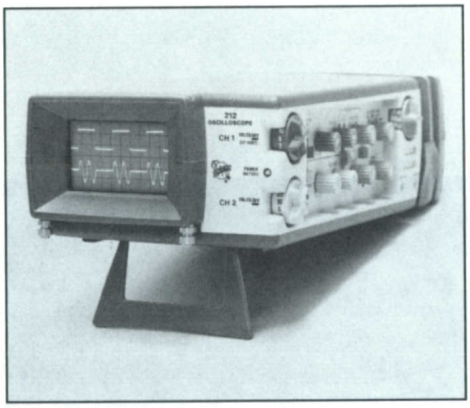
Number of Digits—3½ digits plus decimal point and sign.
Display Size—1 cm high by 4 cm wide (five characters).
Over-Range Capability—At least 200% of full scale.
Over-Range Indication—Displays scrambled characters.

ORDERING INFORMATION

213—Miniscope/DMM **$3,300**
Includes: Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two alligator clip to banana jack test leads (red 012-0015-00, black 012-0014-00); neck strap (346-0104-00); two power line fuses (159-0080-00); identification tag (334-2614-00); identification tag (000-7983-00); service manual (070-1481-00); operator manual (070-1480-00).
Option 01—180 to 250 V ac (48 to 62 Hz) or dc. **NC**
Includes: In addition to above, power line plug (161-0077-01).

OPTIONAL ACCESSORIES

Alligator Clip Kit—A pair of alligator clips that allow connecting the probe and ground lead to large (up to 3/8 in.) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01). Order 015-0231-00 **$26**
Probe Tips—(To BNC Panel Connector Adapter) Order 013-0084-01 (To BNC Cable Adapter) Order 103-0096-00 **$13.75**
Power Cable Adapter Assembly—An 11-inch two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$9.25**



212

- **500 kHz, 1 mV/Div to 50 V/Div**
- **Internal Battery Pack**
- **Integral 1 MΩ Probe**
- **Weighs ≈1.6 kg (3.5 lb)**

TYPICAL APPLICATIONS

Electromechanical Measurements
Biomedical

The 212 features bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds), compact (3×5.25×9.5 inches), and built of impact-resistant plastic and fully self-contained. It permits "floating" measurements since it is double insulated, and can be elevated to 700 V (dc+peak ac) above ground when operated from batteries.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. Clip-on 10X attenuators are available for higher-voltage applications. Trigger level and slope functions are simplified to one rotary control on the side of the unit.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth—DC to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

Deflection Factors—1 mV/div to 50 V/div (1-2-5 sequence). Accuracy: ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

Display Modes—CH 1 only, CH 2 only, or CH 1 and CH 2 Chopped (chop rate ≈50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C—≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Maximum Input Voltage*1

1 to 50 mV/div	600 V (dc +peak ac), ac not over 2 kHz.
0.1 to 50 V/div	600 V (dc +peak ac), 600 V p-p ac 5 MHz or less

*1 *1X probe only.*

HORIZONTAL SYSTEM

Time Base—5 μs/div to 500 ms/div ±5%.

Variable Magnifier—Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

External Horizontal Input— (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

Maximum External Horizontal Input Voltage and Impedance—Same as for vertical inputs.

TRIGGERING

Modes—Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input. In dual-channel operation at a setting of 1 mV/div, a bright baseline may not appear in the Auto Trigger Mode.

Trigger Sensitivity and Coupling

DC Coupling	To 500 Hz
Internal w/composite trigger source	0.2 div
Internal w/CH 2 trigger source	0.2 div
External	1 V

Maximum External Trigger Input Voltage—8 V (dc+peak ac), 16 V (p-p ac) at 500 kHz or less.

Input Impedance—R and C, 1 MΩ paralleled by ≈30 pF.

CRT AND DISPLAY FEATURES

CRT—6×10 div (0.52 cm/div) display. Standard phosphor: GH (P31).

Graticule—Internal, black line, nonilluminated.

OTHER CHARACTERISTICS

Insulation Voltage—500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (dc + peak ac) not to exceed 350 V.

Power Sources—Internal NiCad batteries provide ≈three to five hours operation for a charging and operating temperature between +20 and +30° C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries. A pilot light battery-charge indicator light will extinguish when oscilloscope has about ten minutes of operating time remaining in the batteries.

POWER REQUIREMENTS

Line-Voltage Range—110 to 126 V ac. Can be operated at 104 to 110 V ac with resulting slow discharge of internal batteries. Option 01 is 220 to 250 V. Option 02 is 90 to 110 V.

Line Frequency—58 to 62 Hz. Options 01 and 02 are 48 to 52 Hz.

Maximum Power Consumption—3 W.

ENVIRONMENTAL

Ambient Temperature—Operating (Battery only): −15 to +55° C. Charging or operating from ac Line: 0 to +40°C. Nonoperating: −40 to +60° C.

Altitude—Operating: 7500 m (25,000 ft), decrease maximum temperature by 1° C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration—Operating and Nonoperating: 15 minutes along each of the three major axes. 0.06 cm (0.025 in.) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles. Held for 3 minutes at 55 Hz.

Humidity—95%, five cycles (120 hours). Referenced to MIL-T-28800C, par 4.5.5.1.2.2.

Shock—Operating and Nonoperating: 150 g's, ½ sine, 2-ms duration in each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	133	5.3
Height	76	3.0
Depth	241	9.5
Weight ≈	**kg**	**lb**
Net, w/o accessories	1.6	3.5
Shipping	3.2	7.0

ORDERING INFORMATION

212 Dual-Trace Oscilloscope **$2,095**

Includes: Integral probes, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121 00); identification tags (000-7983-00); identification tag (334-2614 00); carrying strap (346-0104-00); service manual (070-5053-00); operator manual (070-5052-00).

OPTIONS

Option 01—For 220 to 250 V (48 to 52 Hz). **NC**
Includes: Batteries.

Option 02—For 90 to 110 V (48 to 52 Hz). **NC**
Includes: Batteries.

OPTIONAL ACCESSORIES

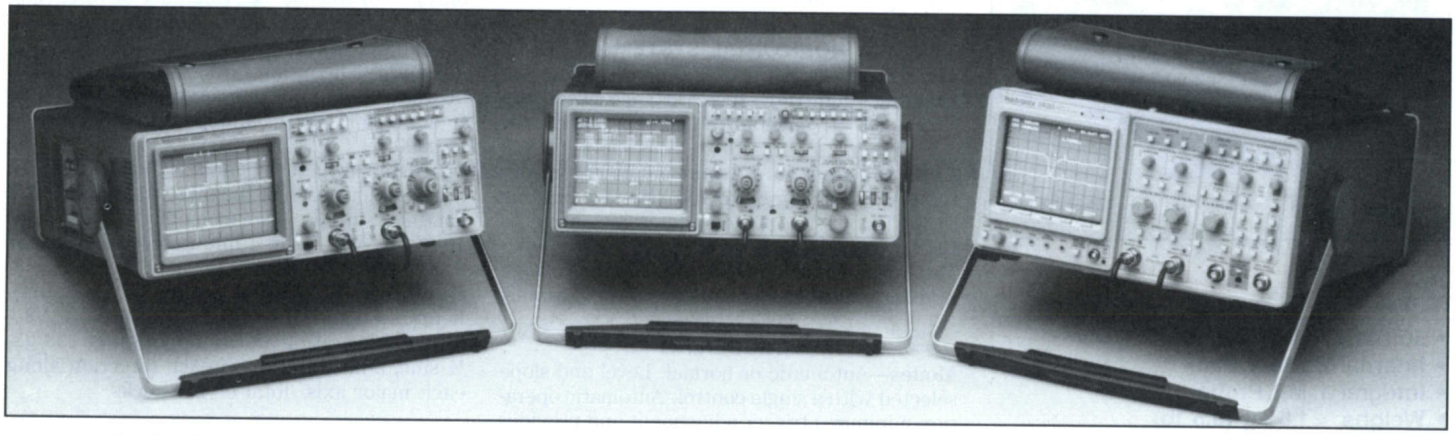
10X Attenuator Package—Tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc +peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adapter (206-0203-00).
Order 010-0378-01 **$70**

Alligator Clip Kit—See 213 optional accessories for description. Order 015-0231-00 **$26**

Probe Tips—To BNC Adapters (Panel Connector) Order 013-0084-01 **$10**
(Cable Adapter) Order 103-0096-00 **$13.75**

Power Cable Adapter Assembly—See 213 optional accessories for description. Order 161-0077-01 **$9.25**

PORTABLE STORAGE OSCILLOSCOPES



CONTENTS

Portable CRT Storage
466 100 MHz Dual Trace, Dual Time Base 347
314 10 MHz Dual Trace 350
214 500 kHz Dual Trace 351
Portable Digital Storage
2430A 150 MHz Digital Storage . . 346
2430M 150 MHz Digital Storage with MATE/CIIL 346
2220 60 MHz Digital Storage 346
2221 60 MHz Digital Storage 346
2230 100 MHz Digital Storage 346
336 50 MHz Digital Storage 368
DCS01 Digitizing Camera System . 390

Now Tektronix gives you five choices in portable digital-storage oscilloscopes. They build on the high value, high performance standards that Tektronix is famous for. They also set some standards of their own—in performance, price and ease of use.

NEW 2430A/2430M

Digital-Storage Oscilloscopes

GPIB IEEE-488 The 2430A/2430M comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **150-MHz Bandwidth at Probe Tip**
- **5-ns/Div Sweep Speed**
- **100 MS/s Sample Rate**
- **Simultaneous Acquisition of Two Channels**
- **Automatic Set Up**
- **Envelope Mode With 2-ns Glitch Capture**
- **Waveform Parameter Measurement**
- **Built-in Help Text**
- **8-Bit Resolution Over 10 Divisions**
- **Save on Delta (Tek Patented Feature) Provides Unattended Pass/Fail Testing and Babysitting Against a User-Defined Reference or Envelope**
- **Extensive Trigger Capability Such as Delay-by-Time, Delay-by-Events; Two External Trigger Inputs Provide Flexibility for Use in TTL, ECL, and Analog Circuit Applications**
- **Save Up to Six Waveforms for Later Display, Analysis and Comparison**
- **Full-Screen Readout and Extensive Cursor Functions for Easy Operation and Measurements**
- **Fully GPIB Programmable for Systems and Automated Test Applications**
- **Three-Year Warranty—Five Years Optional**

The Tek 2430A/2430M features 150-MHz bandwidth, a 100-MS/s digitizing rate, and dual-channel acquisition.

It's a powerful combination that lets you digitize, view, and store high-bandwidth and complex signals. Also offering 8-bit vertical resolution, 1K record length per channel, and a 0.001% crystal-controlled time base, the 2430A is an advanced measurement package with many sophisticated capabilities including 2-ns glitch capture at any sample rate.

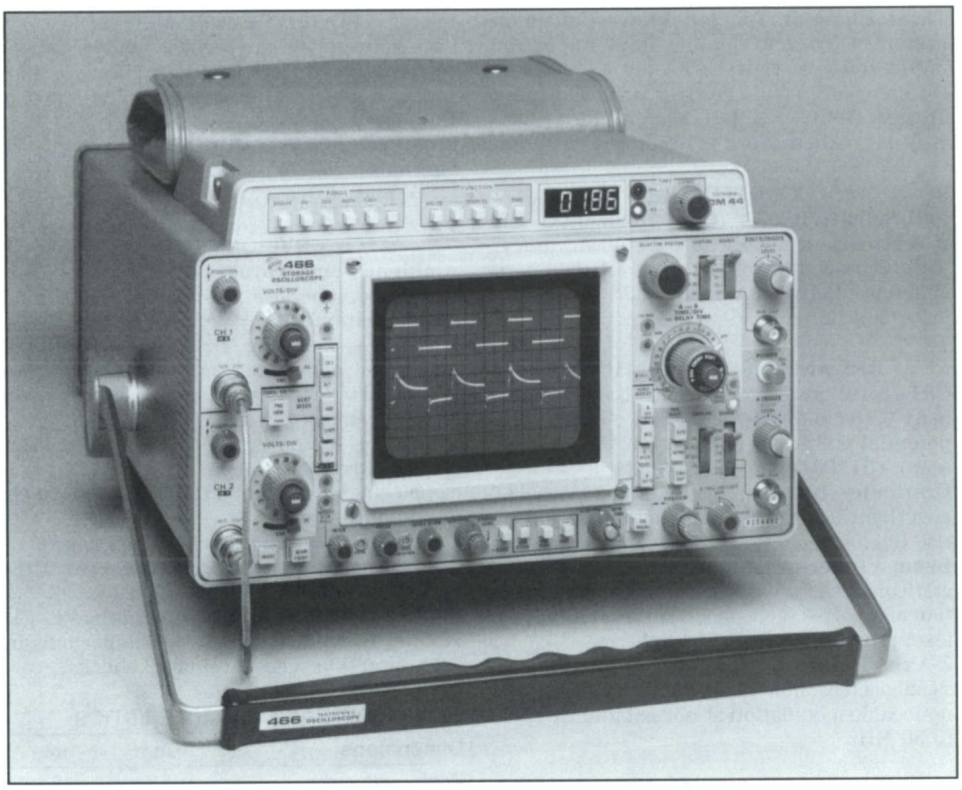
2230/2221/2220

Digital Storage Oscilloscopes

GPIB IEEE-488 The 2220/2221 & 2230 Option 10 comply with IEEE Standard 488-1978 and use Tektronix *Standard Codes and Formats.* The 2220, 2221, Option 12 and 2230 feature Standard RS-232-C and use Tektronix *Standard Codes and Formats.*

- **100-MHz Digital Storage and Nonstorage (2230)**
- **60-MHz Digital Storage and Nonstorage (2220/2221)**
- **100-ns Glitch Capture at Any Sweep Speed**
- **Cursors and CRT Readout for Time and Voltage Measurements (2230/2221)**
- **Pre/Post Triggering**
- **4K Record Length**
- **Scan/Roll-Scan Mode for Capture of Transient Events**
- **Post Acquisition Expansion, Compression, and Positioning (2230)**
- **GPIB or RS-232C Optional**
- **26K Battery-Backed Save-Reference Memory (2230 Option 10 or 12)**
- **Three-Year Warranty—Five Years Optional**

If it's economy you want for performance that's best in its class, the Tek 2200 Series DSO's offer solid features at exceptional prices.
Included: storage and nonstorage bandwidth of 100 MHz in the 2230 and 60 MHz in the 2220/2221. Sampling at 20 MS/s with 8-bit vertical resolution with 100-ns glitch capture at any sweep speed. Plus 4K record length with save-reference memory and expansion, compression, and positioning of save-reference waveforms.



466 with Differential Time/DMM Option (466 DM44).

466

- **100 MHz at 5 mV/Div**
- **5-ns/Div Sweep Rate with X10 Sweep Magnifier**
- **Variable-Persistence and Fast-Mesh-Transfer Storage Modes**
- **3000-Div/μs Stored Writing Speed**
- **Battery Operation (Optional)**
- **Third Channel Trigger View**
- **Weighs ≈11.8 kg (26 lb)**

TYPICAL APPLICATIONS

Disk/Tape-Drive Logic Design
Laser-Pulse Analysis
Low-Rep-Rate Radar-Pulse Analysis
Destructive-Test Monitoring

The 466 Portable Storage Oscilloscope is designed to display nonrepetitive or slow moving signals.

Operating in a reduced-scan mode, the stored writing speed is 3000 div/μs (1350 cm/μs). This instrument features two modes of storage—variable persistence and fast transfer.

The bright 8×10-div CRT has 0.90-cm divisions. A reduced-scan 8×10-div graticule is superimposed over the center of the main graticule, with 0.45-cm divisions. The graticule is etched onto the inner face of the CRT to eliminate parallax problems.

A third channel trigger view allows the simultaneous display of channels 1 and 2 with the external A trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the front panel when the probe attenuation factor is switched.

Lightweight plus the ability to use optional, external dc power makes the 466 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

CHARACTERISTICS

VERTICAL SYSTEM
(2 IDENTICAL CHANNELS)

Bandwidth*1 and Rise Time—At all deflection factors from 50 Ω terminated source.

−15 to +40°C	+40 to +55°C
DC to 100 MHz, ≤3.5 ns	DC to 85 MHz, ≤4.15 ns

*1 *Measured at −3 dB down. Bandwidth may be limited to ≈20 MHz by bandwidth-limit switch. Lower −3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.*

Deflection Factor—5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to ≈12.5 V/div. In cascade mode, sensitivity is ≈1 mV/div. Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50 Ω.

Display Modes—CH 1, CH 2 (normal or inverted), Alternate, Chopped (≈250 kHz), added, X-Y.

Common-Mode Rejection Ratio—At least 20 dB at 20 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor—Probe-tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground-reference display selectable at probe (when dc coupled).

Input R and C—1 MΩ ±2% paralleled by ≈20 pF.

Maximum Input Voltage

DC Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
AC Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Time Base A—0.05μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

Time Base B—0.05μs/div to 50 ms/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

Variable Time Control—Time Base A: Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy*2

	+20 to +30°C	−15 to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

*2 *Full 10 divisions.*

Display Modes—A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep—Displays A sweep for period determined by Delay-Time Position control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range—0.2 to X10 delay Time/div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

Differential Time-Measurement Accuracy

Delay Time Setting	+15 to +35°C	−15 to +55°C
Over one or more major dial div	±1%	±2.5%
Less than one major dial div	±0.01 major dial div	±0.025 major dial div

Jitter—One part or less in 50,000 (0.002%) of X10 the A-sweep time/div setting.

TRIGGERING

A Trigger Modes—Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff—Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

B Trigger Modes—B starts after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A-sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
DC Internal	0.3 div	1.5 div
DC External	50 mV	150 mV
DC External÷10	500 mV	1.5 V
AC	Requirements increase below 60 Hz	
AC LF Reject	Requirements increase below 50 kHz	
AC HF Reject	Requirements increase below 30 Hz and above 50 kHz	

Jitter—0.5 ns or less at 100 MHz and 5 ns/div (X10 magnifier).

A Trigger View—A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A-sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external÷10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

A Sources—Normal, CH 1, CH 2 line, external, and external ÷10.

B Sources—Starts after delay, normal, CH 1, CH 2, and external.

External Inputs—R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

Third Channel Trigger View—Deflection Factor (DC Trigger Coupling Only). Ext is: 100 mV/div ±5%. Ext÷10 is: 1 V/div ±5%. Delay Difference: 5.0 ±0.5 ns after vertical display. Trigger Point: ≈center screen. Rise time: ≤ 5 ns. −Aberration: <10% p-p.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)—5 mV/div to 5 V/div. Accuracy: ±4%. Bandwidth: DC to at least 4 MHz. Phase Difference Between Amplifiers: 3° or less from dc to 50 kHz.

CRT AND DISPLAY FEATURES

CRT—8×10-div display, each div is 0.9 cm (normal); 0.45-cm/div reduced scan. Accelerating potential is 8.5 kV (normal), 10 kV (reduced scan). GH (P31) phosphor standard.

Graticule—Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder—Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

Z-Axis Input—DC coupled, positive-going signal decreases intensity; 5-V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

STORED WRITING SPEEDS

Full Scan*1	Stored Writing Speed	Storage*2 View Time
Fast Transfer	67.5 cm/μs	>15 s
Variable Persistence	0.225 cm/μs	>15 s
Reduced Scan*3		
Fast Transfer	135 cm/μs	>15 s
Variable Persistence	1.35 cm/μs	>15 s*1

*1 *Center 6×8 division; 0.9 cm/division.*

*2 *These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in Save Display Mode.*

*3 *Center 8×10 division; 0.45 cm/division.*

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0 to +40°C
Output Current	30 mA	2% +20 to +30°C
Frequency	≈1 kHz	

Vertical Signal Output—CH 1 vertical signal is dc to at least 50 MHz and ≈25 mV/div terminated into 50Ω, and ≈50 mV/div terminated into 1 MΩ.

Gate Outputs—Positive gates from both time bases (≈5 V).

POWER REQUIREMENTS

Line-Voltage Range—Quick change, line-voltage selector provides 110, 115, 120, 220, 230, and 240 V ac, each ±10%. Option 07 is 12 to 24 V dc.

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—100 W at 115 V and 60 Hz.

ENVIRONMENTAL

Ambient Temperature—Operating: −15 to +55°C. Nonoperating: −55 to +75°C. Forced air ventilation is provided.

Altitude—Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1° C/1000 ft from 5,000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

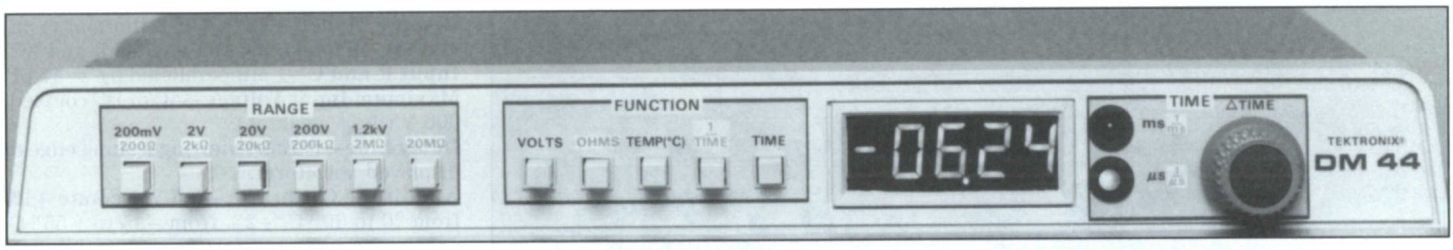
Vibration—Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Humidity—Operating and Nonoperating: 95%, 5 cycles (120 hours). Referenced to MIL-T-28800C, par. 4.5.5.1.2.2.

Shock—Operating and Nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width, w/handle	330	13.1
Height, w/o pouch	159	6.2
Depth, w/panel cover	550	21.7
Depth, handle extended	597	23.8
Weight ≈	**kg**	**lb**
Net, w/o panel cover or accessories	11.8	26.0
Net, w/panel cover & accessories	13.5	29.8
Shipping	18.8	41.5



DM 44

Differential Time/DMM Option for 466

- **3½-Digit LED Display**
- **Time Intervals Accurate to 1%**
- **Frequency Accurate to 2%**
- **DC-Voltage Measurements Accurate to 0.1%**
- **Resistance Accurate to 0.3%**
- **Temperature From −55 to +150°C**

One-percent timing measurements were never this easy! With the DM 44 Option, time intervals can be read directly from the 3½-digit LED screen. Simply use the Delay Time control and the ΔTime Dial to superimpose the end of the interval on the beginning. Then read its differential time or frequency from the 3½-digit LED panel. It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44. It measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55 to +150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

CHARACTERISTICS

TIMING MEASUREMENTS

Differential Time Delay Accuracy

+15 to +35°C	−15 to +55°C
Within 1% of reading ±1 count	Within 2.5% of reading ±1 count

1/Time Accuracy

+15 to +35°C	−15 to +55°C
Within 2% of reading ±1 count	Within 3.5% of reading ±1 count

DC VOLTAGE

Ranges—0 to 200 mV, 0 to 2 V, 0 to 20 V, 0 to 200 V, 0 to 1.2 kV.
Resolution—100 μV.
Accuracy—Within 0.1% of reading ±1 count.
Input Resistance—10 MΩ for all ranges. Removal of an internal strap increases resistance to ≈1000 MΩ on 200-mV and 2-V ranges.
Normal-Mode Rejection Ratio—At least 60 dB at 50 and 60 Hz.
Common-Mode Rejection Ratio—At least 100 dB at dc, 80 dB at 50 and 60 Hz.
Recycle Rate—≈3.3 measurements/s.
Response Time—Within 0.5 s.
Maximum Safe Input Voltage—±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

RESISTANCE

Ranges—0 to 200 Ω, 0 to 2 kΩ, 0 to 20 kΩ, 0 to 200 kΩ, 0 to 2 MΩ and 0 to 20 MΩ.
Resolution—0.1 Ω.

Accuracy

Range	Accuracy
200 Ω	Within 0.25% ±1 count + probe resistance
2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ	Within 0.25% ±1 count
20 MΩ	Within 0.3% ±1 count

Recycle Rate—≈3.3 measurements/s.

Response Time

200-Ω through 200-kΩ ranges	Within 1 s
2-MΩ through 20-MΩ ranges	Within 5 s

Maximum Safe Input Voltage—120 V RMS between + and common inputs.

TEMPERATURE USING P6430 PROBE

Range—−55 to +150°C.

Accuracy

DM 44 Temperature	P6430 Tip Temperature	Accuracy Probe Calibrated to DM 44)
+15 to +35°C	−55 to +150°C	±2°C
−15 to +55°C	−55 to +125°C +125 to +150°C	±3°C ±4°C

ORDERING INFORMATION

466 Storage Oscilloscope **$8,590**
Includes: Two P6105A probes; blue accessory pouch (016-0535-02); clear pouch (016-0537-00); CRT light filter (337-1674-01); two 1½-A fuses (159-0016-00); one ¾-A fuse (159-0042-00); ground-wire adapter (134-0016-01); viewing hood (016-0592-00); operator manual (070-2037-00).

466 DM 44 Storage Oscilloscope/ DMM **$9,375**
Includes: Same as 466 plus, one pair test leads (003-0120-00); one P6430 Temperature Probe (010-6430-00); service manual (070-2036-01); operator manual (070-4796 00).

OPTIONS

Option 01—Delete DM 44 Temperature Probe (466 DM 44 only). **−$90**
Option 04—EMC Capability. **+$220**
Option 05—TV Sync Separator (Provides Triggering on TV Field). **+$385**
Option 07—External DC Operation (Not for DM 44). **+$330**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.

OPTIONAL ACCESSORIES

1106—Battery Pack (used with Option 07). **$1,580**
1105—Battery Power Supply **$2,090**
Mesh Filter—Improves display contrast in high ambient light. Order 378-0726-01 **$90**
Protective Cover—Waterproof vinyl. Order 016-0365-00 **$27**
Viewing Hoods—
(Folding) Order 016-0592-00 **$14.25**
(Folding Binocular) Order 016-0566-00 **$19**
(Polarized Collapsible) Order 016-0180-00 **$60**
Rack adapter—Not for DM 44. Order 016-0676-00 **$450**
A6902B Voltage Isolator—For floating measurements. See Accessories Section. **$1,885**

RECOMMENDED PROBES

(See Accessories Section)
P6105A—10X Probe. **$93**
P6062B—1X/10X Probe. **$175**

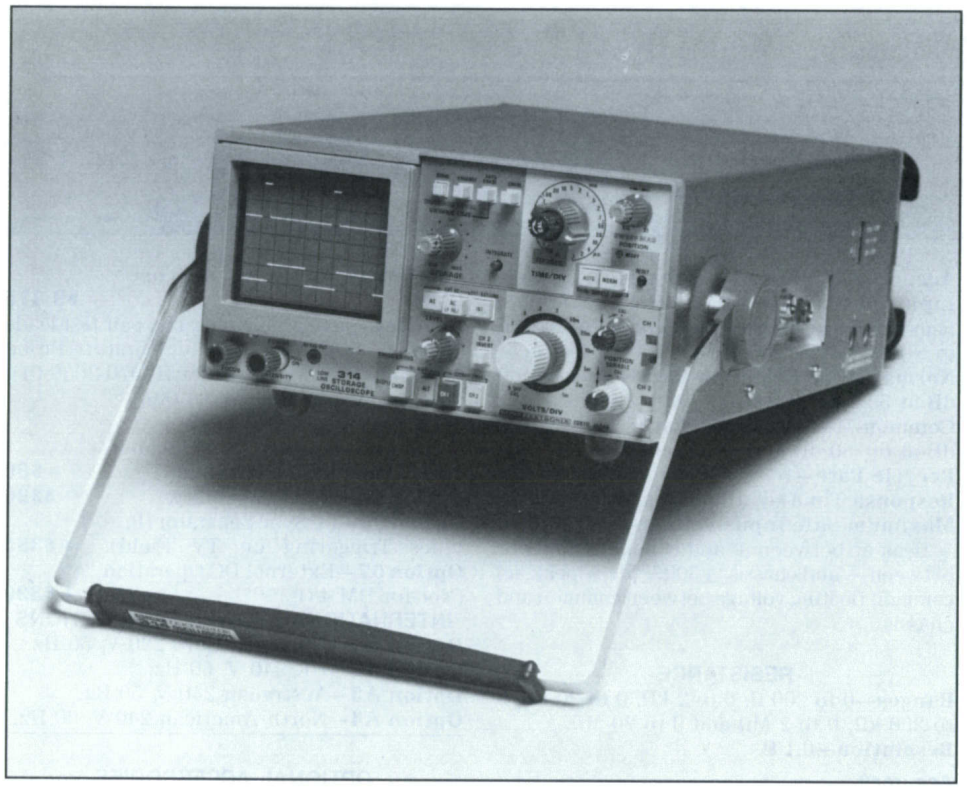
RECOMMENDED CAMERA

C-30BP Option 01—General Purpose Camera. Includes 016-0301-01 mounting adapter/corrector lens. **$1,548**

RECOMMENDED CART

K212—For on-site portability. See Accessories Section. **$350**

Modification kits for field conversion of existing 466s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, distributor, or representative for information.



314

- **10 MHz at 1 mV/Div**
- **100-ns/Div Sweep Rate With X10 Sweep Magnifier**
- **Stored Viewing Time to 4 Hours**
- **Integrate Mode for Intensifying Fast Rise-Time, Low-Repetition-Rate Signals**
- **Operates From ac Line, 12 V dc, or 24 V dc**
- **Small Size, Weighs ≈4.7 kg (10.5 lb)**

TYPICAL APPLICATIONS

Industrial Control Systems
Biophysical Instrumentation
Communication Equipment Service

The 10.5 pound, bistable-storage 314 provides 1-mV/div sensitivity at 10 MHz, with a four-hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast rise-time, low-repetition-rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac or external dc sources mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1-mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 second to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth and Rise Time—DC to at least 10 MHz. Rise time: 35 ns or less for a 4-div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.
Deflection Factor—1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated: Continuously variable between steps to at least 25 V/div.
Display Modes—CH 1, CH 2 (normal or inverted), chopped, alternate, added, and X-Y.
Input R and C—1 MΩ paralleled by ≈ 47 pF.
Maximum Input Voltage—AC or DC coupled, 300 V (dc + peak ac).
Delay Line—Permits viewing leading edge of displayed waveform.
Amplitude Calibrator—0.5 V accurate ±1% from 20 to 30° C, ±2% from −15 to +55° C.

HORIZONTAL SYSTEM

Time Base—1 μs/div to 5 s/div. X10 magnifier extends sweep rate to 100 ns/div.
Variable Time Control—Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

Time Base Accuracy*1

Unmagnified	
1 μs/div to 0.2 s/div	±3%
0.5 s/div to 5 s/div	±4%
Magnified	
50 ms/div to 0.5 s/div	±5%
0.5 μs/div to 20 ms/div	±4%
0.1 μs/div and 0.2 μs/div	±5%

*1 *Center 8 divisions.*

TRIGGERING

Modes—Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

Trigger Sources—Internal: CH 1, CH 2, or composite; external.

Sensitivity and Coupling

Coupling	1 MHz	10 MHz
DC Internal	0.3 div	1 div
DC External	150 mV	500 mV
AC	Requirements increase below 30 Hz	
AC LF Reject	Requirements increase below 50 kHz	

X-Y OPERATION

Input—X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.
X-Axis Deflection Factors—Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.
Input Impedance—1 MΩ ± 2% paralleled by ≈62 pF.

CRT AND DISPLAY FEATURES

CRT—8×10-div (0.6 cm/div) display. Accelerating potential is 2 kV. GX (P44) phosphor.
Graticule—Internal, nonilluminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.
Z-Axis Input Range—+5 to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Maximum input voltage, 50 V (dc + peak ac).

STORAGE FEATURES

Display Modes—Direct view, bistable storage, and nonstore modes. Enhance mode to increase stored writing rate in the single-sweep mode. Autoerase mode to automatically erase stored display after each sweep. Viewing time before autoerase can be varied from 1 s or less to at least 5 s. Integrate mode increases stored brightness of very fast repetitive signals.
Stored Writing Speed—Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.
Erase Time—300 ms.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 130 V ac or 180 to 264 V ac.
Line Frequency—48 to 440 Hz.
Power Consumption—29 W maximum at 115 V ac.
External DC Source—+11 to +14 V dc or +22 to +28 V dc.
DC Current Drain—1.6 A at +12 V or 0.8 A at +24 V.

ENVIRONMENTAL

Ambient Temperature—Operating: −15 to +55 °C. Nonoperating: −40 to +75 °C.
Altitude—Operating: 6000 m (20,000 ft) maximum, decrease maximum temperature by 1 °C/1000 ft from 5000 to 20,000 ft. Nonoperating: 15 000 m (50,000 ft) maximum.
Vibration— Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.
Humidity—Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25 °C ±5 °C and 20% to 80% relative humidity.
Shock—Operating and Nonoperating: 30 g's, ½ sine, 11-ms duration each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width, w/handle	236	9.3
Height, w/o pouch	112	4.4
Depth, handle not extended	347	13.6
Weight ≈	**kg**	**lb**
Net, w/o accessories	4.7	10.5
Shipping	7.6	17.0

ORDERING INFORMATION

314 Storage Oscilloscope **$4,935**
Includes: Two P6149A 10X probes; carrying case and pouch (016-0612-00); strap (346-0131-02); external dc-cable assembly (012-0406-00); two 1.6-A fuses (159-0098-00); two 0.8-A fuses (159-0132-00); two 0.15-A fuses (159 0130-01); three 0.16-A fuses (159-0131-00); service manual (070-1824 00); operator manual (070-1823-00).
The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

RECOMMENDED PROBES

P6149A—10X Probe **$110**

RECOMMENDED CAMERA

C-30BP Option 01—General Purpose Camera. **$1,548**
Camera Adapter—Required to mount the C-30BP to the 314. Order 016-0327-01 **$175**

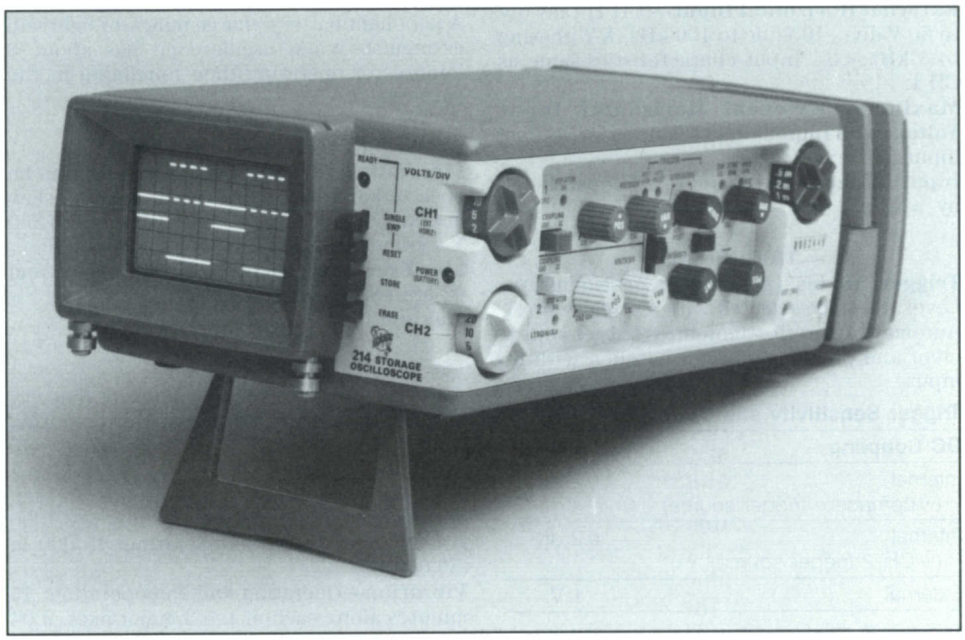
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

214

- **500 kHz, 1 mV/Div to 50 V/Div**
- **Internal Battery**
- **Integral 1-MΩ Probe**
- **Weighs ≈1.6 kg (3.5 lb)**

TYPICAL APPLICATIONS

Industrial Control Systems
Electromechanical Measurements



The 214 features these signal-acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3×5.3×9.5 inches). The 214 offers bistable storage capabilities. This is useful for viewing nonrepetitive or slow-moving signals.

Built of impact-resistant plastic and fully self contained, this miniature portable is ideal for applications in severe environments. It permits 'floating'' measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single-sweep mode, the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth—DC to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

Deflection Factors—1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

Display Modes—CH 1 only. CH 2 only, or CH 1 and CH 2 chopped (≈chop rate 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C—≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Maximum Input Voltage

1 mV/div to 50 mV/div	600 V (dc+peak ac), ac not over 2 kHz
0.1 V/div to 50 V/div	600 V (dc+peak ac), 600 V p-p ac; 5 MHz or less

*[1] *1X Probe only.*

HORIZONTAL SYSTEM

Time Base—5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier—Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

External Horizontal Input—(CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

Maximum External Horizontal Input Voltage and Impedance—Same as for vertical inputs.

Input Impedance—R and C, 1 MΩ paralleled by ≈30 pF.

TRIGGERING

Trigger Modes (Automatic or Normal)—Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

DC Coupling	To 500 Hz
Internal (w/composite trigger source)	0.2 div
Internal (w/CH 2 trigger source)	0.2 div
External	1 V

Maximum External Trigger Input Voltage—8 V (dc+peak ac), 16 V (p-p) at 500 kHz or less.

Single Sweep—Sweep generator produces one sweep when trigger is received.

CRT AND DISPLAY FEATURES

CRT—Bistable storage, 6×10-div (0.52 cm/div) display. GX (P44) phosphor.

Graticule—Internal, black line, nonilluminated.

STORAGE FEATURES

Stored Writing Speed—Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

Stored Luminance—At least 8 fL at 25°C.

Storage Viewing Time—≈1 hour.

OTHER CHARACTERISTICS

Insulation Voltage—500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line voltage +dc +peak ac not to exceed 350 V.

Power Sources—Internal NiCad batteries provide ≈3.5 to 5 hours operation (≈2.5 to 3.5 hours in 214 stored mode) for a charging and operating temperature between +20 and +30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 minutes of operating time remaining in the batteries.

POWER REQUIREMENTS

Line-Voltage Range—110 to 126 V ac. Can be operated at 104 to 110 V with resulting slow discharge of batteries. Option 01 is 220 to 250 V. Option 02 is 90 to 110 V.

Line Frequency—58 to 62 Hz. Options 01 and 02 are 48 to 52 Hz.

Maximum Power Consumption—3 W.

ENVIRONMENTAL

Ambient Temperature—Operating (battery only): −15 to +55° C. Charging or operating from ac line: 0 to +40°C. Nonoperating: −40 to +60°C.

Altitude—Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration—Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in.) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles. Held for 3 minutes at 55 Hz.

Humidity—95%, 5 cycles (120 hours). Referenced to MIL-T-28800C, par. 4.5.5.1.2.2.

Shock—Operating and Nonoperating: 150 g's, ½ sine, 2-ms duration in each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	133	5.3
Height	76	3.0
Depth	241	9.5
Weight ≈	**kg**	**lb**
Net w/o accessories	1.6	3.5
Shipping	3.2	7.0

ORDERING INFORMATION

214 Dual-Trace Storage Oscilloscope **$2,865**

Includes: Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121 00); identification tags (000-7983-00); identification tag (334-2614 00); carrying strap (346-0104-00); service manual (070-5055-00); operator manual (070-5054-00).

OPTIONS

Option 01—For 220 to 250 V (48 to 52 Hz). **NC**

Option 02—For 90 to 110 V (48 to 52 Hz). **NC**

OPTIONAL ACCESSORIES

10X Attenuator Package—A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc +peak ac). Includes: flex tip (206-0060-00); 10X attenuator (010-0378-01); pincher tip (013-0071-00); banana tip (134-0013-00); IC adapter (206-0203-00). Order 010-0378-01 **$70**

Alligator Clip Kit—A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to 3/8 in.) conductors. Includes: 6-32 to probe adapter (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 **$26**

Probe Tips
(To BNC Panel Connector adapter) Order 013-0084-01 **$10**
(To BNC Cable Adapter) Order 103-0096-00 **$13.75**

Power Cable Adapter Assembly—A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$9.25**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect (503) 627-9000, Ext. 99.

AUTOMATED TEST SYSTEMS AND INSTRUMENTS

CONTENTS

Digitizers 354
Digital Camera System 390
Controllers and Peripherals 392
Software
TekMAP 374
ASYST 376
11000-Series Utility 377
SPD 378
TEK EZ-TEST 397
GURU II 398
Measurement Packages 400
Signal Routing/DUT Interfacing Products 420
NEW 371 and 370 Programmable Curve Tracers 407
TM 5000 Programmable Instruments 434

Tektronix offers a variety of programmable instruments to meet your measurement needs, starting with a wide performance base of GPIB-compatible waveform digitizers with capabilities up to 14 GHz. With the 7D20 digitizer plug-in, your existing Tektronix 7000-Series oscilloscope can become a GPIB programmable waveform digitizer—another example of our designed-in commitment to expandability.

Plus, we have a broad range of other GPIB programmable instruments to complete your system—signal and power sources, measurement devices, switchers, spectrum analyzers, multifunction interface units. They are all supported by a selection of instrument controllers, peripherals, and software.

We provide extensive and ongoing documentation—hardware and software manuals, controller programming guides, instrument-interfacing guides, application notes, even a regular newsletter on signal processing and instrument control. In addition, an instrumentation software library provides programs to help you develop software to solve your measurement problems.

Configurability

Tek systems offerings afford maximum flexibility, right down to the number of ways in which they can be configured.

1. Individual systems components are available separately and include instrument-interfacing guides, documentation and, in some specific cases, application software available through the Tektronix Instrument Software Library.
2. Preconfigured measurement packages (MP) make it easy to purchase the most needed components in a packaged system that you integrate and install yourself. Instruments contained in measurement packages carry the normal, standalone instrument warranty and do not include on-site installation.
3. Custom systems are generally modified/expanded versions of our standard packages and include integration, checkout software, on-site installation, and warranty. They do not include device-specific application software.

Whatever your needs, from a single GPIB instrument to a complete measurement system, we're sure you'll find the right measure of performance in the pages that follow. Take the time to evaluate your own unique needs—and our uniquely personal solutions. You'll be making an investment in performance that will pay dividends for years.

Programming Ease

With Tektronix programmable instruments, compatibility is the key. It's more than just IEEE Standard 488 compatibility; it's total system compatibility, from configuring to programming. This higher level of compatibility is achieved through conformance to the additional standard of Tektronix *Standard Codes and Formats*. For more information on this important standard, refer to the GPIB section or contact a Tektronix Sales Representative.

DIGITIZERS

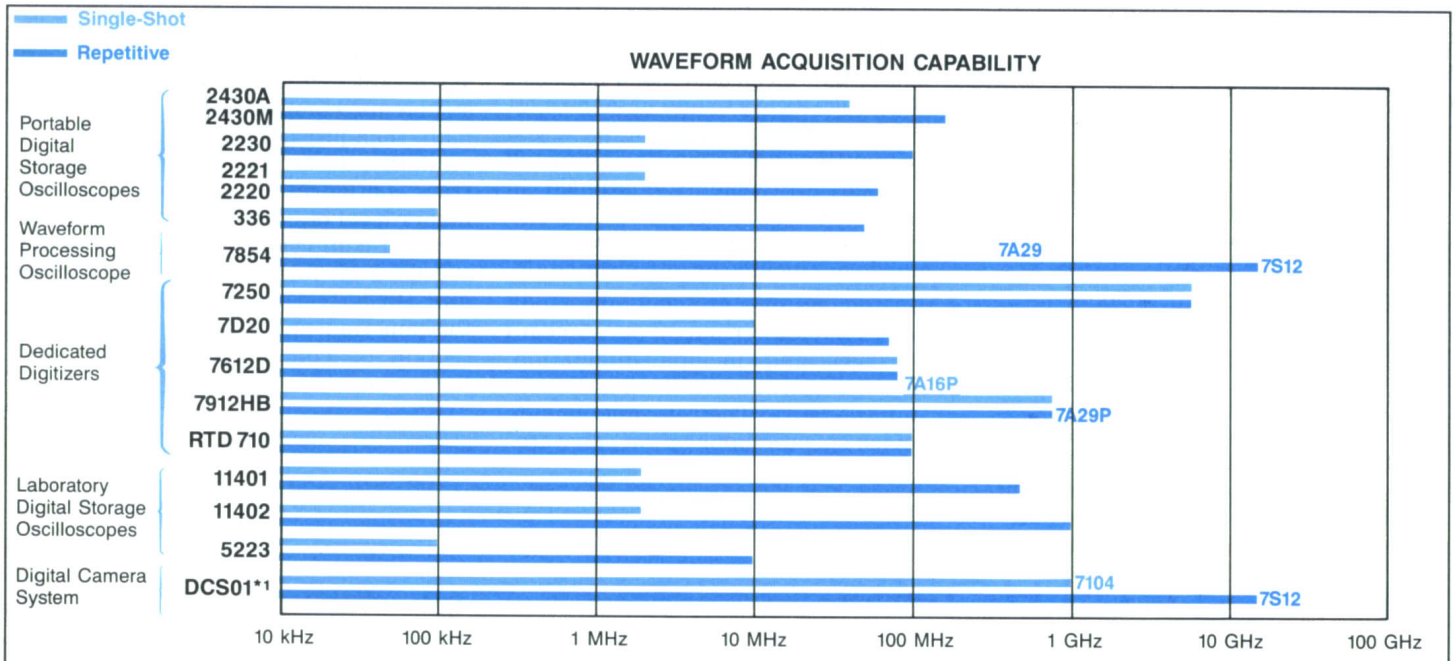
CONTENTS

Oscilloscopes
11401,11402 Programmable Digitizing 355
7250 6-GHz Digitizing 356
2430M Portable Digital-Storage . . 358
2430A Portable Digital-Storage . . 358
2220/2221 Portable Digital-Storage 364
2230 Portable Digital-Storage . . . 364
336 Portable Digital-Storage 368
7D20 Programmable Digitizer 370
7854 Waveform Processing 372
5223 Digital-Storage 387
Digitizers
7612D Programmable Waveform . . 379
7A16P Programmable Amplifier . . 381
7912HB Programmable Waveform 382
7A29P Programmable Amplifier 383
7B90P Programmable Time Base 383
RTD 710 Programmable Waveform 384
5B25N Digital Time Base 389
Software
TekMap, ASYST, SPD 374
DCS01 Digital Camera System . . . 390

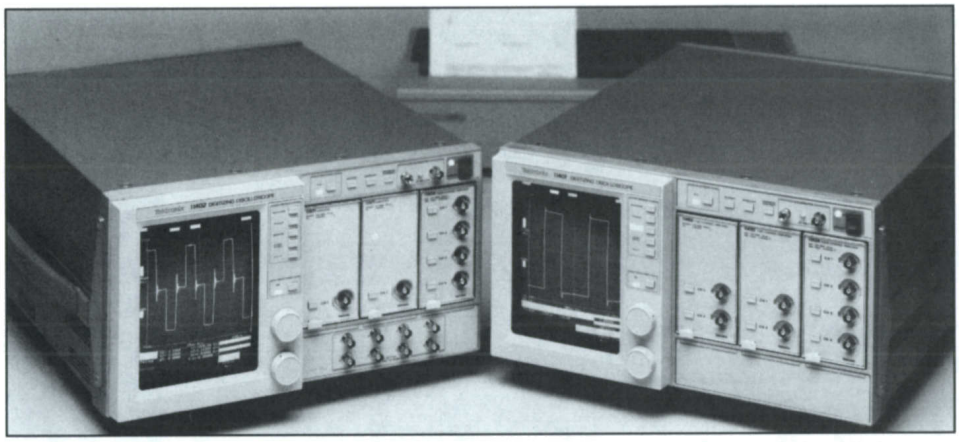
DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

Type	Analog Digitizing BW	Maximum Digitizing Rate	Vertical Resolution	Data Words per Waveform	Maximum Stored Waveforms	Useful*1 Storage BW (SS)	Equiv*2 Storage BW (rep)
11401	500 MHz	20 MS/sec	10 bits*3	Up to 10,240	100K pts	2 MHz	500 MHz
11402	1 GHz	20 MS/sec	10 bits*3	Up to 10,240	100K pts	2 MHz	1 GHz
5223	10 MHz	1 MHz	10 bits	1016/plug-in	2 to 4	100 kHz	10 MHz
336	50 MHz	1 MS/s	8 bits	1024 each channel	2 (16 with option)	100 kHz	50 MHz
2220	60 MHz	20 MS/s	8 bits	2048 dual channel 4096 single channel	2	2 MHz	60 MHz
2221	60 MHz	20 MS/s	8 bits		2	2 MHz	60 MHz
2230	100 MHz	20 MS/s	8 bits	2048 dual channel 4096 single channel	8 (+52 with option)	2 MHz	100 MHz
7854	400 MHz*4	500-kHz Ext Clock	10 bits	Up to 1024	Up to 40	50 kHz	400 MHz
7D20	70 MHz	40 MHz	8 bits	Up to 1024	6	10 MHz	70 MHz
2430A	150 MHz	100 MS/s	8 bits	1024	6	40 MHz	150 MHz
RTD 710	100 MHz	200 MHz single channel	10 bits	1 to 64K	64	100 MHz	100 MHz
7612D	80 MHz	200 MHz	8 bits	Up to 2048	2 to 16	80 MHz	80 MHz
7912HB	750 MHz	100 GHz	9 bits	512	1	750 MHz	750 MHz
DCS01/ 7104	1 GHz	250 GHz 9-bits sing.	12-bits rep.	512	26	1 GHz	1 GHz
7250	6 GHz	1000 GS/s	11 bits	512	15	6 GHz	6 GHz

*1 *Useful Storage Bandwidth is a measure of the highest frequency sine wave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.*
*2 *Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent-time digitizing techniques.*
*3 *14 bits with averaging.*
*4 *14 GHz with sampling.*



*1 The DCS01 is limited only by the photographic writing speed and bandwidth of the display instrument.



11400 Series
Digitizing Oscilloscopes

GPIB IEEE-488 — The 11400 Series complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **1-GHz and 500-MHz Bandwidths**
- **8 Channels of Display and Acquisition**
- **Plug-In Modularity**
- **Waveform Processing and Automatic Measurements**
- **Multiple 10,240-Point Waveform Records**
- **Differential, High-Impedance, and 50-Ω Input Amplifiers**
- **Greatly Simplified Access to Features**

The 11401 and 11402 are the first in a line of programmable digitizing oscilloscopes. These versatile scopes, along with the array of plug-ins and probes that support them, solve measurement problems equally well on a designer's bench or in a programmable test system. Digital designers will benefit from flexible triggering features and an eight-channel display. Analog and power-supply designers can apply extensive waveform processing to signals acquired through high-performance differential and single-ended amplifiers. 11000-Series digitizing scopes can follow your designs into production. Full programmability via either IEEE-488 or RS-232C, and features like a DMA controller for fast waveform transfers make these scopes a perfect fit for systems. 11000-Series Digitizing Oscilloscopes set new standards in performance and excellence.

Live Display of Up to Eight Traces

The 11401/402 each support three vertical-amplifier plug-ins. This means you can acquire up to eight channels of data at 300 MHz, up to six channels of data at 600 MHz, or up to three channels of data at 1 GHz. You can, of course, mix and match the plug-ins to design the system that works best for you. Eight traces can be displayed at any one time so that you can get the whole picture on one screen. The update rate is so fast that the 11401/402 have the look and feel of analog scopes.

High Vertical and Horizontal Resolution

The 11401 and 11402 uniquely combine wide bandwidth with 10-ps horizontal resolution and 10-bit vertical resolution. Other vendors have made a tradeoff: bandwidth for vertical resolution or vertical resolution for bandwidth. The 11401/402's trigger-to-trigger measurement feature delivers 200-ps precision on single-shot time A→B measurements and can even get down to 10-ps precision with averaging. Trigger-to-trigger measurements of this nature are only available on the 11401/402 and a few expensive stand-alone counter/timers. Also, window records can be used to increase horizontal resolution on specific segments of main records to provide a clear picture of signal details.

Long Multiple Record Lengths

The 11401/402 can acquire multiple records of up to 10,240 points each. No other scope can capture as much data at once on repetitive waveforms. The mainframes can contain up to 100K points of waveform memory. Long records and large storage capacity combine to let users gather data over relatively long periods of time with high resolution and improved measurement accuracy. One doesn't need a computer to log waveform data. Waveforms can be stored on-board the scope for later analysis.

Versatility for a Wide Range of Applications

Five vertical plug-ins and three probes bring outstanding versatility to the 11401/402. The measurement system and waveform-processing functions lead to quick solutions to a wide variety of voltage, time, area and energy problems. The 11401 can process and measure signals from high-bandwidth 50-Ω amplifiers, high-impedance amplifiers, and differential amplifiers. 1-mV sensitivity and 500 V maximum input voltage let users capture small signals from transducers or monitor ac power lines.

See 11000-Series section for complete description and specifications.

11000 SERIES BANDWIDTH/RISE-TIME MATRIX

Plug-In	11402	11401
11A71 Single Channel, 10 mV/div, 50 Ω	1 GHz/350 ps	500 MHz/700 ps
11A52 Dual channel, 1 mV/div, 50 Ω	600 MHz/540 ps	500 MHz/700 ps
11A32 Dual Channel, 1 mV/div, 1 MΩ/50 Ω	400 MHz/1 ns	400 MHz/1 ns
11A34 Four Channel, 1 mV/div, 1 MΩ/50 Ω	300 MHz/1.2 ns	300 MHz/1.2 ns
11A33 Differential Comparator, 1 mV/div, 1 MΩ/1 GΩ	150 MHz/2.4 ns	150 MHz/2.4 ns

7250 Transient-Digitizing Oscilloscope

GPIB IEEE-488

The 7250 partially complies with IEEE Standard 488-1978 and Tektronix *Standard Codes and Formats.*

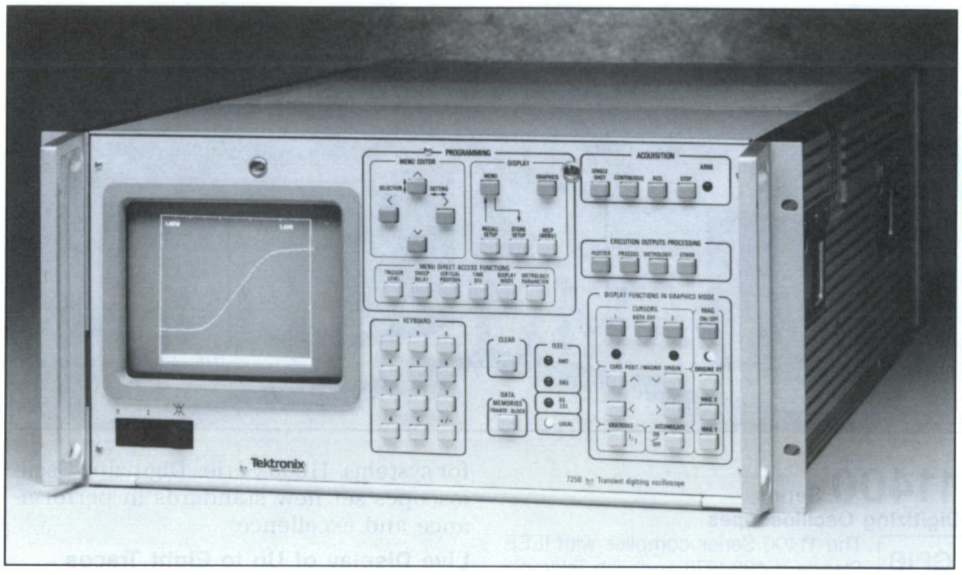
- **6-GHz Bandwidth**
- **50-ps Rise Time**
- **5-V Full-Scale Sensitivity**
- **11-Bits (2048 Points) Vertical Resolution**
- **50-ps/Div Fastest Sweep**
- **9-Bits (512 Points) Horizontal Resolution**
- **Trigger Jitter 100 ps or Less**
- **Fully Programmable Via GPIB**
- **Programmable Sweep Delay**
- **Internal Memory To Save 15 (Optional 31) Waveform Acquisitions And 4 Front-Panel Setups With Five-Year Battery Backup**
- **Target-Defect Correction**
- **Filtering And Smoothing**
- **On-Screen Cursors**
- **Built-In Waveform-Parameter Measurements**
- **Sinusoidal Sweep (Rossi) Input Capability**

The Tektronix 7250 Transient-Digitizing Oscilloscope is a high-speed instrument that can acquire fast single-shot or repetitive signals and display them digitally. It is designed specifically to capture and record very high-frequency, fast rise-time pulses. The instrument provides a dc to 6-GHz (−3 dB) bandwidth, 50-picosecond rise time, and is fully programmble via GPIB.

Transient Digitizing Lets You View and Digitize Single-Shot Events or Non-repetitive Waveforms.
The scan conversion used in the 7250 lets you do all this at very high frequencies and fast rise times, something most digitizing oscilloscopes cannot do. Waveforms are processed for display on the TV-type monitor.

Other major features of the 7250 are menu-driven operation and on-screen cursors for ease of operation. Fast setup, immediate feedback with the built-in monitor, and interactive controls also contribute to operating ease.

Split-screen operation lets you compare a stored waveform with a newly acquired waveform or display two acquisitions on one screen. The ability to measure important waveform parameters is built-in, and it is fully programmable via GPIB. Also, the instrument is designed to rigorous standards for modularity, easy repair, and ruggedness. It is built to maintain its performance in adverse environments.



APPLICATIONS

Particle Physics Research

The challenge in this type of research is the recording of nonrepetitive, high-voltage, fast-rise, narrow pulses. The 7250 was built specifically for these kinds of measurements and handles them with ease. These types of signals cannot be measured on most digitizers or digital-storage scopes because they require repetitive waveforms and typically do not handle the high frequencies and fast transition times involved.

High-Power Laser Research

A transient-digitizing oscilloscope is the ideal instrument for capturing transient electrical phenomena in laser research. The 7250 can capture and digitize this data and, because the instrument is fully programmable and GPIB compatible, the data can be fed directly to a minicomputer for fast analysis after each laser shot.

CHARACTERISTICS

VERTICAL

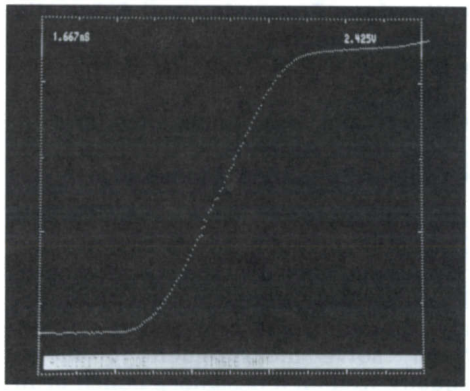
Bandwidth—DC to 6 GHz (−3 dB).
Rise Time—50 ps ±5 ps.
Sensitivity—5 V±15%, full scale.
Input Impedance—50 Ω ±2 Ω.
Input VSWR—Less than 1.5 (0 to 2 GHz), less than 2.5 (2.5 to 7 GHz).
Loop-Through Transmission-Line Loss—Less than 2 dB (0 to 5 GHz).
Maximum Input Voltage—2 kV (1-μs duration).
Vertical Position—0 to 100% in 1% steps.

HORIZONTAL

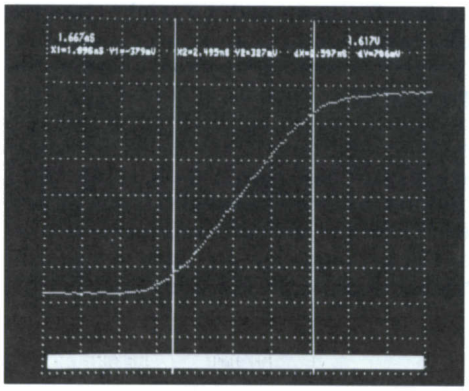
Sweep Rates—1 μs to 50 ps/div, 14 ranges in a 1,2,5 sequence.
Sweep Accuracy—2% over center 8 divisions.
Sweep Linearity—1.5% of full scale on center 8 divisions. No worse than 0.15 division in any one division.

TRIGGERING

Source—External triggering only. Requires 50-ns, ± slope pre-trigger signal. Optional delay line provides trigger pick-off.
Coupling—direct.



7250 CRT display of pulse rise-time measurement.

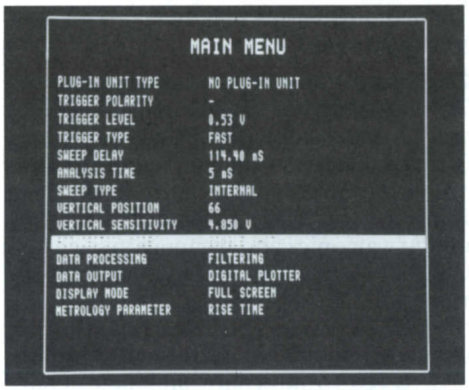


7250 CRT photo of on-screen cursors. Cursors show the vertical and horizontal setting at any two points on the display, plus the difference between these two points.

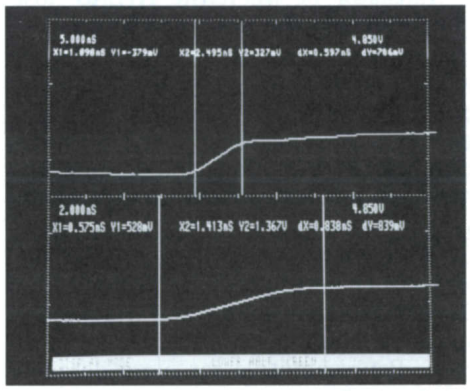
Level—Programmable 50 mV to 10 V in two ranges.
Modes—Normal: pulse duration greater than 10 ns; Fast: pulse duration greater than 400 ps and less than 20 ns.
Input Impedance—50 Ω ±5%.
Maximum Input—250 mW, 500 V peak-to-peak at 1-μs duration.
Jitter—100 ps or less (peak-to-peak).
Delay Drift—±500 ps, over the period of 10 minutes to 1 hour at 50 ps/div and 100-ns sweep delay.
Sweep Delay—Minimum delay 50 ns ±2 ns. Adjustable in 5 ranges: 50 to 100 ns (50-ps resolution), 100 to 150 ns (100-ps resolution), 150 to 500 ns (500-ps resolution), 500 ns to 1 μs (1-ns resolution), and 1 to 5 μs (5-ns resolution).

DIGITIZER

Resolution—11 bits vertical, 9 bits horizontal (2048 vertical points, 512 horizontal points).
Memory—Internal memory to save 15 waveform acquisitions (31 acquisitions with optional additional memory) with five-year battery backup. Can also save 4 front-panel setups.



7250 CRT photo of MAIN MENU. The MAIN MENU lets you select and change the parameter you want. Other menus available are secondary MENU for setting internal parameters and a HELP MENU for viewing the choice of settings available.



7250 CRT photo of split-screen display. The split screen lets you display and make measurements on two waveforms simultaneously.

WAVEFORM PROCESSING

Target Defect Correction—Corrects for defects in the reading-tube image target.
Filtering—Redundant y values are suppressed and missing y values are created.
Smoothing—Mathematical smoothing operation based on averaging over adjacent points.

Acquisition Modes

Single Shot—Acquires and displays a waveform one time.
Continuous—Continuously acquires and displays waveforms.
Burst—Acquires and stores several waveforms in successive memory blocks. Number of acquisitions is set by the user up to the maximum memory locations.
Average—Acquires and averages a number of waveform acquisitions, then displays the averaged waveform. Number of averages is set by the user, 256 maximum.
Envelope—Acquires a number of waveforms set by the user, 256 maximum. After the last acquisition, the envelope is updated, and the curve is displayed.
Defects Correction—Acquires a waveform a number of times set by the user. A table of faults from the waveform is updated in memory for subtraction from any stored curve.
Electrical Zero—Allows acquisition of an electrical baseline, and acquires a waveform a number of times set by the user. At each acquisition, an average curve in a buffer area is updated. After the last acquisition, an electrical zero value is calculated, stored, and can then be used with the cursors.

WAVEFORM MEASUREMENT

Electronic Graticules—Full screen or border only.
Cursors—Two vertical cursors with CRT readout of x and y coordinates of cursor and waveform crossing point, plus delta time and voltage between cursors.
Magnifier—Cross-hair type cursors for setting display window to be magnified. Provides up to 16 times magnification both vertically and horizontally.
Automatic Measurement—Min/max, peak-to-peak, average value, rms value, rise time/fall time, pulse width, delay time, delta time.

INPUTS/OUTPUTS

Signal Input, Signal Output, GPIB*[1], Control Video, Trigger Input.
RS 232C—Plotter output.
Video Monitor-CCIR output and sync input.
External Sweep Input—Allows use of sinusoidal (Rossi) sweep to 3 GHz.

*[1] *Does not comply with all provisions of IEEE 488-1978 or with Tektronix Standard Codes and Formats.*

OPTION 01 EXTERNAL DELAY LINE

Bandwidth—≥4.5 GHz.
Attenuation—4.5 dB ±0.5 dB.
Delay—55 ns ±2 ns.
Rise Time—≤75 ps.
Maximum Input Voltage—5 Vdc.
Maximum Pulse Input—60 V.
Input Impedance—50Ω ±5%.
Input/Output Connectors—N type.
Trigger Pickoff—Attenuation, 20 dB±1 dB; rise time 300 ps; connector, BNC.
Dimensions—19-in. rack width; 2 rack units height; 32.5-in. (800 mm) depth.

ENVIRONMENTAL

Temperature—Operating: 0 to 40°C. Nonoperating: −10 to 70°C.
Altitude—Operating: 3 km (10,000 ft). Nonoperating: 12 km (40,000 ft).
Humidity—Operating: 90% at 40°C.

POWER REQUIREMENTS

Line Voltage—115 V ±10%, 220 V ± 10%.
Line Frequency—50 to 60 Hz ±4%.
Power Consumption—200 W.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	483	19.0
Height	222	8.7
Depth	915	36.0
Weight ≈	**kg**	**lb**
Net	60	132.3
Shipping	110	242

ORDERING INFORMATION

7250—6-GHz Transient-Digitizing Oscilloscope **$99,995**

OPTIONS

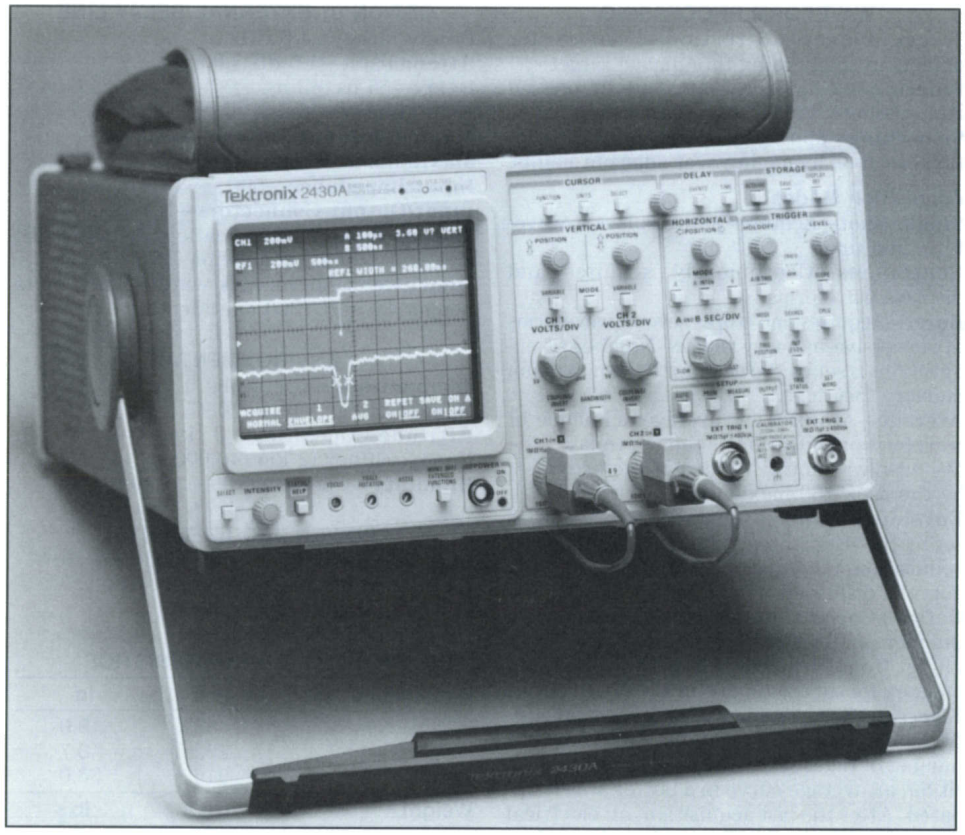
Option 01—External delay line **+$12,500**
Option 2D—Extended Memory **+$2,400**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220V, 50 Hz.
Option A2—UK 240V, 50 Hz.
Option A5—Switzerland 220V, 50 Hz.

OPTIONAL ACCESSORIES
(See Accessories section)

HC01—4×5 in. Video Copier **$995**
HC02—8×10 in. Video Copier **$1,325**



NEW 2430A/2430M

Digital Oscilloscopes

GPIB IEEE-488 The 2430A/2430M comply with IEEE standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **150 MHz X/Y Bandwidth at Probe Tip**
- **New Time-Saving Local Test Features That Simplify and Automate Scope Setups and Measurements**
- **100 MS/s Digitizing Rate**
- **Simultaneous Acquisition on Two Channels**
- **Envelope Mode with 2-ns Glitch Capture**
- **AutoStep for Building, Storing, and Running Test Procedures—Without Coding**
- **Auto Setup for Quick Scope Set-ups, Even With Unknown Signals**
- **Save on Delta for Unattended Pass/Fail Decision Making**
- **Waveform Parameter Extraction for Making Complex Measurements**
- **Extensive Triggering Capabilities: Delay by Time, Delay by Events, and Two External Trigger Inputs**
- **Full GPIB Programmability**
- **Three-Year Warranty, Five Years Optional**

TYPICAL APPLICATIONS

Analog and Digital Design
Repetitive Tests
Power-Supply Development

The Tektronix 2430A Digital Oscilloscope adds timesaving innovations to high standards of technical performance. The result is a powerful and versatile scope that speeds measurements, simplifies setups, and automates test procedures—all from the front panel.

A Fully Programmble, Proven Scope

The 2430A's 150-MHz bandwidth and dual-channel 100 MS/s digitizing rate enable you to digitize, view, and store wide-bandwidth, complex signals.

Add 8-bit vertical resolution, 1K record length per channel, and a 0.001% crystal-controlled time base for accurate voltage and time measurements.

New and powerful features quickly set up the scope, build and store test procedures from the front panel, conduct pass/fail tests, and provide on-line operating instructions.

Add extensive triggering capabilities for solving tough problems in research, design, and manufacturing.

The result is the 2430A, a new, standard-setting digital oscilloscope from the leader in digital test-and-measurement instruments.

Local Test™ Features—More Power in Your Scope

See signals in less time, automatically, with the 2430A's new Auto Setup feature. Simply connect your probe to a circuit and press Auto Setup. In seconds, a scaled, triggered, and positioned display appears on screen.

Get the answers you need at the touch of a button with menu-selectable Waveform Parameter Extraction. You select the measurement, and the 2430A makes the measurements and displays readouts and waveforms on screen—no more counting divisions or moving cursors.

Save time for you and your system with the AutoStep sequencer, a powerful test building, storage, and transmission feature for semiautomated and automated systems. Test procedures built with AutoStep run with little or no controller or operator attention.

Eliminate grease pens and CRT overlays—use Save on Delta to compare incoming waveforms to a reference you define. If the incoming waveform is out of limits, the 2430A automatically saves it, alerts the operator with a bell, or sends an SRQ to the system.

2430M with MATE/CIIL Capabilities

The 2430M digital oscilloscope offers Control Intermediate Interface Language (CIIL) capability that is essential for operation in Modular Automatic Test Equipment (MATE) used in testing military avionics and weapons systems. A CIIL interface allows communication between an ATLAS 716 host computer and the 2430M via the IEEE 488 bus. This interface is embedded in the 2430M. Upon a GAL (go to alternate language) command, the 2430M is essentially transparent to the IEEE bus until a CIIL command is received. When a CIIL command appears on the bus, the CIIL interface is automatically invoked and acts as a translator between the ATLAS host computer and the IEEE 488 bus.

The 2430M was designed to the Proposed MATE System Control Interface Standard No. 2806763 Rev. B and has been accepted as a candidate for MATE qualification. All 2430A options and optional accessories are also available on the 2430M.

Due to the method of processing messages, software written for the 2430A may not be entirely compatible with the 2430M when using SRQs and when sending long messages. Contact your local Sales Representative for more detailed information.

FEATURES

The following features are common to both instruments.

AutoStep Sequencer

Saves and recalls 50 to 200 front-panel setups, user prompts, test procedures, and associated control and I/O actions in up to 40 named test sequences.

Saving Test Setups—Saved steps include all front-panel control settings for measurement and printer/plotter control.
Saving Actions—Selectable actions include test looping, self-calibration, self-test, Auto Setup, printing/plotting, ringing a bell, sending SRQs, and pausing between steps.
Editing—Full front-panel editing capabilities include creating, deleting, and copying tests, as well as adding, deleting, copying, and moving front-panel setups and actions.
Recalling Tests—Provides pushbutton or external execution of saved test steps in automatic or semiautomatic modes.
External Control—Offers extended external IEEE Standard 488 control.
External (BNC) Step Advance Input—Step-complete and sequence-complete outputs (all are TTL compatible) for AutoStep Sequencer.

Auto Setup

Automatically configures controls to display the selected channel according to the selected modes: View and Measurement mode: Period, Pulse, or Edge.
View Mode—Displays one channel with ground at screen center. Displays two channels with ground ±two divisions. Horizontally scales for three to six cycles.
Measurement Modes—Provides vertical scaling for one or both channels centered unless the dc offset is too large to be offset by the position control. If the offset is excessive, the vertical rules (described in View Mode) apply.

In "Lo Res," the vertical will be scaled between 2.0 and 4.5 div. In "Hi Res," it will be scaled between 3 and 8 div.

Period—Horizontally scales for one cycle within the display (Lo Res) or one cycle within the record (Hi Res).

Pulse—Horizontally scales the narrower of the two pulse widths within the display (Lo Res) or within the record (Hi Res); selects the polarity of the Slope as required.

Edge—Horizontally scales the rising or falling edge to be within 3 divisions (Lo Res) or 9 divisions (Hi Res); selects the polarity of the slope as selected.

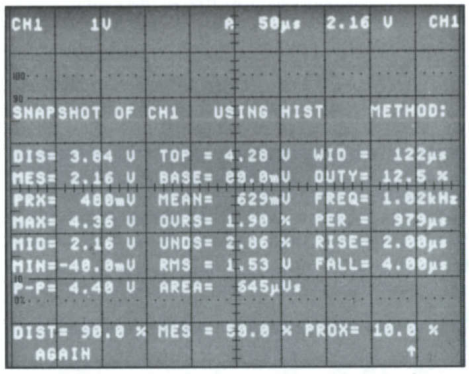
Save on Delta

Compares incoming waveforms to a user-definable waveform envelope, and saves the waveforms that are outside reference limits. For examination, Saved (Event that Caused Save On Delta trigger) events are horizontally positioned at center screen.

Waveform Parameter Extraction

Two modes of operation:

1. Simultaneously measure up to four parameters on one or more dislayed waveforms. Parameter readouts are updated at 3-Hz intervals.
2. Display a snapshot of 20 waveform parameters on a single waveform target.



Snapshot freezes and displays, on one screen, all 20 of the automatic, single-channel measurements. This convenient feature is suited to applications such as moving from point to point while evaluating prototype circuits.

Waveform Parameters Measured—Frequency, period, width, rise time, fall time, propagation delay, duty cycle, overshoot, undershoot, RMS, area, minimum, maximum, mid, peak-to-peak, mean, base, top, proximal, mesial, and distal.
Thresholds—Settable in percentage or voltage.
Determining 0% and 100% Levels—Three methods available.
Threshold Crossing Locations Indication— Visual.
Windowing Capability—Measurement windows defined by cursors.
Indications—Extensive warning and error-condition indication capabilities.

CHARACTERISTICS

VERTICAL SYSTEM

The following characteristics are common to both instruments.
Bandwidth—DC to 150 MHz (−3 dB) for dc input coupling; <10 Hz to 150 MHz for ac.
Channels—Two, with simultaneous acquisition.
Bandwidth Limit—20 or 50 MHz; selectable (reduces −3 dB point to between 13 and 24 MHz (for 20 MHz selection).
Vertical Accuracy—±2% +1 digitizing level (25 digitizing levels per CRT division).
Deflection Factor— 2 mV to 5 V/div in 1-2-5 sequence, continuously variable between ranges.
Auto Scale Factor—On-screen readout indicates probe-tip deflection factors for 1X, 10X, 100X, and 1000X probes. Scale factor also available over GPIB Bus. Probe identification available via on-screen readout.
Delay Matching—±250 ps.
Channel Isolation—100:1 or greater attenuation of the deselected channel at 100 MHz (50:1 or greater at 150 MHz) for a 10-div input signal from 2 to 500 mV/div and for the same Volts/Div settings on both channels.
Maximum Input Voltage—1-MΩ input with dc, ac, and gnd coupled selections: 400 V (dc +peak ac); 800 V p-p ac at 10 kHz or less. For 50-Ω: 5 V RMS; 0.5 W sec for any 1 s interval for instantaneous voltages from 5 to 50 V.
Input R and C—1-MΩ ±0.5% paralleled by 15 pF ±2 pF. For 50-Ω input ±1%.
VSWR—≤1.3:1 for dc to 150 MHz.
Vertical Position Range—±(10, +0.4, −0.7) divisions.
CMRR—At least 10:1 at 50 MHz for common-mode signals of 10 div or less, and Var Volts/Div adjusted for best CMRR at 50 kHz at any Volts/Div setting from 5 mV to 5 V.

HORIZONTAL SYSTEM

Display Modes—A, A Intensified, and B.
A and B Delayed Sweep Range— 5 ns to 5 s/div in 1-2-5 sequence.
Clock Accuracy—0.001%.
External Clock Repetition Rate—Minimum is 1 MHz. Maximum is 100 MHz.

Signal Levels Required for EXT Clock or Events

Coupling	CH 1 or CH 2 Source	EXT 1 or EXT 2 Source Gain=1
DC	0.70 div from dc to 20 MHz increasing to 2.0 div at 100 MHz. 3.0 div at 100 MHz in ADD mode.	35 mV from dc to 20 MHz increasing to 100 mV at 100 MHz.
Noise Rej	≤2.4 div from dc to 20 MHz; increasing to 6.0 div at 100 MHz. 9.0 div at 100 MHz in ADD mode.	≥120 mV from dc to 20 MHz; increasing to 300 mV at 100 MHz.
AC	0.7 div from 60 Hz to 20 MHz; increasing to 2.0 div at 100 MHz; 3.0 div at 100 MHz in ADD mode. Attenuates signals below 60 Hz.	35 mV from 60 Hz to 20 MHz; increasing to 100 mV at 100 MHz; Attenuates signals below 60 Hz.
HF Rej	2.0 div from dc to 30 kHz. Attenuates signals above 30 kHz.	50 mV from dc to 30 kHz.
LF Rej	2.0 div from 80 kHz to 20 MHz; increasing to 4.0 div at 100 MHz; 3.0 div at 100 MHz in ADD mode. Attenuates signals below 80 kHz.	50 mV from 80 kHz to 20 MHz; increasing to 100 mV at 100 MHz.

Signal Levels Required for EXT clock or EVENTS: GAIN=+5: Amplitudes are 5 times those specified for Ext. Gain=1.

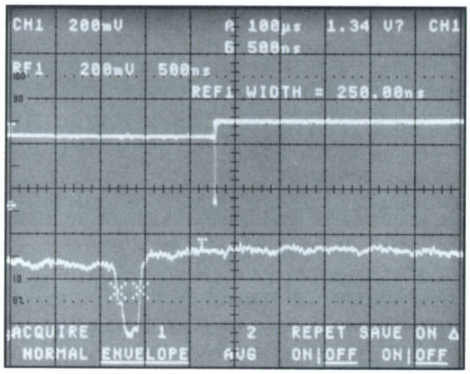
Delay By Time and Delta Delay—On-screen readout will display time delay between measured events.
Delay By Time and Delta Delay Range—From the greater of (0.04×B s/div) or 20 ns.
Delay by Events—Delays the A or B sweep by a user-selected number of B trigger events after the normal A trigger occurs. On-screen readout indicates number of events selected. The maximum number of events selectable is 65,536 with one-event resolution.
Delay Time Resolution—At 5 s to 500 ns/div, the greater of (0.04×B s/div) or 20 ns.

ACQUISITION SYSTEM

Maximum Single Event Useful Storage Bandwidth—40 MHz (using internal Modified Sine X/X interpolator).
Maximum Sample Rate—100 MS/s on two simultaneous channels.
Vertical Resolution—8 bits (1 to 256 over 10.24 vertical div).
Record Length—1024 points per channel.

Acquisition Modes

Normal Mode—Provides normal real-time sampling of input signals. For sweep speeds from 5s to 500 ns/div, 1024 real data points are acquired and displayable with each trigger. At sweep speeds from 200 to 5 ns/div, if Repetitive mode is off, modified (sine X)/X interpolation and trigger jitter correction circuitry provide stable, expanded, single-shot displays with 40-MHz Useful Storage Bandwidth. If Repetitive mode is on, the display is built-up in equivalent time from samples acquired with multiple, repetitive triggers, preserving the full 150-MHz vertical-system bandwidth for repetitive signals.



Waveform-Parameter Extraction and 2-ns glitch capture combine for DAC evaluation. The scope displays a DAC output (top waveform) with the glitch highlighted by an intensified zone. In the bottom waveform, the glitch is expanded and stored for comparison and width measurement.

Envelope Mode—Uses internal analog peak detectors to record and display minimum and maximum waveform values over one or more sweeps. Number of waveforms recorded before reset is user selectable in binary sequence from 1 to 256 or continuous.
Envelope Mode Pulse Response (glitch capture)—The following pulse-capture capabilities apply for sweep speeds from 5 s to 5 ns/div if Repetitive mode is off, and from 5 s to 500 ns/div if Repetitive mode is on.

Pulse Duration	% of Amplitude Capture	Confidence Level
2 ns	>50%	>85%
4 ns	>50%	100%
8 ns	>80%	100%

Envelope Mode/Repetitive Function—At sweep speeds between 200 and 5 ns/div, if Repetitive mode is on, Envelope mode acquisition is nearly identical to Normal mode. However, a firmware Envelope generator is activated that stores and displays cumulative minimum and maximum waveform excursions at sequential pairs of equivalent sample points.
Average Mode—Averages continuously for a number of acquisitions from 2 to 256 in binary sequence (selectable from front panel). Averaging of 128 or 256 acquisitions effectively increases vertical resolution to 11 bits and vertical sensitivity to 200 µV/div (for signals containing sufficient noise component). Average mode performs stable averaging for the user-selected number of acquisitions. It then switches to exponential averaging for a weighted averaging of the display until a control or other function is reset.

MEMORY

Nonvolatile Memory—Memory containing calibration data, readout data, an initial front-panel setting, power-down front-panel setting, AutoStep front-panel setup, and action storage. Nonvolatile memory-retention time is more than three years; uses a lithium battery back-up.

DISPLAY

Display Modes—CH 1, CH 2, Invert, Add, Multiply, X/Y (CH 1 vs CH 2, Ref 1 vs Ref 2) reference displays 1 through 4.
Ground Reference Display—Displays a plus (+) at left of screen to track ground location. If ground is off screen, the plus remains at screen perimeter to indicate off-screen direction.

Trigger-Reference Display—T symbol appears on waveform displays to track location of trigger. If trigger point is off screen, T remains on screen at perimeter. T symbol can be turned off by user.

Waveform Expansion—10X vertical expansion of Saved waveforms, in 1-2-5 sequence. 100X horizontal expansion of Saved waveforms, in 1-2-5 sequence. Expanded waveforms can be positioned vertically and horizontally to examine any area of interest.

Readout—Readout characters are displayed on screen to indicate 2430A's vertical channel selection, input coupling and termination, volts/div, time base and s/div, trigger level and trigger-source configuration, as well as menu selections and cursor functions.

Display Update Rate—With 50 kHz trigger, one channel selected, and 100 μs/div sweep speed, fastest update rate possible: 100 Hz, Average, 60 Hz (these are typical performance figures).

ON-SCREEN CURSORS

Functions—Volts, Time, Volts at Time, 1/Time, Slope. User can select these settings for either delta or absolute time/volts (with reference to trigger point/ground). Delta delay makes differential time measurements by using dual delayed sweep.

Units—Volts units may be selected as volts, percent, or dB. Volts at Time units may be selected as volts, percent, or dB. Time units can be selected as seconds, percent, or degrees. 1/Time units can be selected as Hz, percent, or degrees.

TRIGGERING

Following is a summary of triggering functions.

A Mode—Auto Level, Auto/Roll, Normal, Single Sequence.

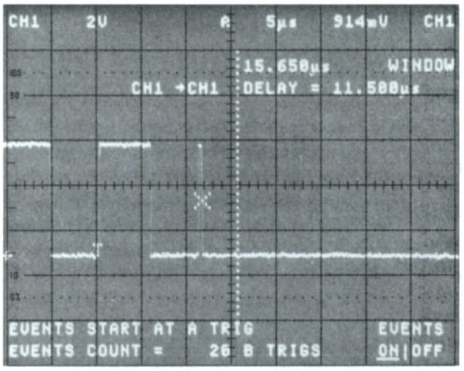
B Mode—Triggerable After Delay, Runs After Delay.

A and B Source—Vertical, CH 1, CH 2, Line (A only), Ext 1, Ext 2, A B (A sweep only), Word (17-bit word recognizer probe, optional accessory).

A and B Coupling—DC, Noise Reject, HF Reject, LF Reject, AC, TV (option: A coupling only).

A and B Trigger Position—$^1/_8$ to $^7/_8$ of acquisition record, user selectable in $^1/_8$-$^1/_4$-$^1/_2$-$^3/_4$-$^7/_8$ sequence. User selectable in 32 sample intervals using GPIB.

A and B Slope (±), A and B Level, External Clock, Init @50%, Vaiable Holdoff, Trigger Status.



With delay by Events, the 2430A can trigger on a single clock pulse within a series to help capture an intermittent failure due to a race condition. The operator here used Absolute Windowing to select the waveform portion from trigger point "T" to the trailing edge of the glitch, indicated by the X marker.

Minimum P-P Signal Amplitude for Stable A Trigger from CH 1, CH 2, or ADD Source—DC Coupled: 0.35 div from dc to 50 MHz, increasing to 1 div at 150 MHz; increasing to 2.5 div at 150 MHz with ADD source. AC Coupled: 0.35 div from 60 Hz to 50 MHz increasing to 1.0 div at 150 MHz; increasing to 1.5 div at 150 MHz with ADD source. LF Reject: 0.5 div from 80 kHz to 50 MHz increasing to 1.0 div at 150 MHz; increasing to 1.5 div at 150 MHz with ADD source. HF Reject: 0.50 div from dc to 30 kHz. Attenuates signals above 30 kHz.

Minimum P-P Signal for Stable Trigger from Ext 1 or Ext 2 Source—DC Coupled: 17.5 mV from dc to 50 MHz, increasing to 50 mV at 150 MHz. Noise Reject Coupling: ≤60 mV from dc to 50 MHz, increasing to 50 mV at 150 MHz. AC Coupled: 17.5 mV from 60 Hz to 50 MHz, increasing to 50 mV at 150 MHz. LF Reject Coupled: 25 mV from 80 kHz to 50 MHz, increasing to 50 mV at 150 MHz. HF Reject Coupled: 25 mV from dc to 30 kHz. Ext÷5: Amplitudes are five times greater than the values given for Ext Gain =1.

Minimum P-P Signal for Stable B Trigger—Two times greater than the values required for stable A trigger.

Ext 1 and Ext 2 Inputs—Resistance: 1 MΩ ±1%. Capacitance: 15 pF ±3 pF. Maximum Input Voltage: 400 V (dc + peak ac), 800 V p-p ac at 10 kHz or less.

Trigger-Level Control Range—CH 1 and CH 2 Source: ±18 div×V/div.
Ext 1 and Ext 2 Source Gain=÷1: ±0.9 V
Ext 1 and Ext 2 Source Gain=÷5: ±4.5 V

REAR-PANEL OUTPUTS AND INPUTS

Channel 2 Output Voltage—20 mV/div ±10% into 1 MΩ. 10 mV/div ±10% into 50 Ω. The −3 dB bandwidth is dc to >50 MHz.

A Trigger, Record Trigger, and Word Recognizer Output—Logic Polarity: negative true trigger occurrence indicated by a HI to LO transition.
Output Voltage HI: ≤400-μA load is 2.5 to 3.5 V. 50-Ω load to ground is ≥0.45 V.
Output Voltage LO: ≤4-mA Load is ≤0.5 V. 50-Ω load to ground is ≥0.15 V.

Direct Hardcopy Output—Sends waveform data, cursor measurements, and instrument configuration over GPIB to an HP 7400 Series plotter, HP ThinkJet, or Tek HC100 Color Pen Plotter. When the 2430A is in the Save On Delta mode and detects an out-of limits signal, the 2430A sends hardcopy output and then reinitializes Save On Delta mode.

POWER REQUIREMENTS

Line-Voltage Ranges—115-V range, 90 to 132 V; 230-V range, 180 to 250 V.

Line Frequency—48 to 440 Hz.

Power Consumption—Typical (standard instruments): 160 W (250 V A). Maximum (fully optioned instruments): 200 W (300 V A).

GPIB PROGRAMMABILITY

GPIB compatibility is a standard feature: full talk-listen modes, control of all front-panel settings, transmitting and receiving waveform data. The 2430A can display 16 lines or prompting messages or computed results via GPIB (40 characters per line) using Tektronix Standard Codes and Formats.

Data Transfer Rate—36-45K B/s depending on sweep speed.

Debug Mode—The 2430A contains an enhanced Debug Mode to help streamline GPIB program development. It permits the user to monitor general bus traffic or traffic to and from the 2430A. Using the 2430A screen, messages are displayed in fast or slow scrolling modes and can be paused at any time. Error and warnings are also displayed.

IEEE Standard 488-1978 Interface Function Subsets Implemented—SH1, AH1, T5, L3, SR1, RL1, DC1, DT0, PP0, C0.

ENVIRONMENTAL AND SAFETY

The 2430A meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style D equipment. Humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.8.2.3, and 3.9.2.4.

Electromagnetic Interference (EMI)—Meets MIL-T-28800C; MIL-STD-461B, Part 4 (CE-03 and CS-02), Part 5 (CS-06 and RS-02), and Part 7 (CS-01, RE-02, and RS-03—limited to 1 GHz); VDE 0871, Category B; Part 15 of FCC Rules and Regulations, Subpart J, Class A; and Tektronix Standard 062-2866-00.

Ambient Temperature—Operating: −15 to +55 °C. Nonoperating: −62 to +85 °C.

Altitude—Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1 °C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration—Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 to 55 Hz in one-minute sweeps. Held ten minutes at each major resonance. Where no major resonance existed, held 10 minutes at 55 Hz (75 minutes total test time).

Humidity—Operating and Nonoperating: Stored at 95% relative humidity for five cycles (120 hours), at +30 to +60 °C, with operational performance checks at +30 and +55 °.

Shock—Operating and Nonoperating: 50 g's, half-sine, 11-ms duration, three shocks on each face, for a total of 18 shocks.

Drip Proof—Front cover meets MIL-T-28800C paragraph 4.5.5.5.3.

Safety—Certified by CSA, Electronic Bulletin No. 556B and UL 1244 and complies with IEC 348.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width (w/handle)	330	13.0	483	19.0
Height			178	17.0
(w/feet & pouch)	190	7.5		
(w/o feet & pouch)	160	6.3		
Depth			419	16.5
(w/front cover)	479	18.9		
(w/handle extended)	550	21.7		
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net			4.0	8.8
(w/accessories & pouch)	12.8	28.1		
(w/o accessories & pouch)	10.9	23.9		
Shipping	16.4	36.0		

Option 05

TV/Video Waveform Measurement System

GPIB IEEE-488 The Option 05 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **All of the High-Performance Characteristics of the Standard 2430A Oscilloscope Plus Television-Waveform Assessment Capabilities**
- **Selectable System-M and Nonsystem-M Protocols**
- **Selectable Triggering on Any Line Within a Field, With Line-Number Readout**
- **GPIB-Controllable Functions for Use in Automatic Measurement Systems**
- **Compatible With Composite Video**
- **Television Blanking-Level Clamp (Back-Porch)**
- **Optimized Vertical Response Comparable to High-Performance Television-Waveform Monitors**

CHARACTERISTICS

The set of characteristics is the same as specified for the standard 2430A Oscilloscope and includes the following additions:

VERTICAL SYSTEM (Channel 1 and Channel 2)

Frequency Response—For Volts/Div switch settings between 5 mV and 0.2 V, with Var Volts/ Div calibrated and using a five-division, 50-kHz reference signal from a 50-Ω system, with external 50 Ω termination on 1-MΩ input.

	Frequency Response	
Frequency Range	**Full BW**	**BW Limiting**
50 kHz to 5 MHz	±1%	+1%, −4%
>5 to 10 MHz	+1%, −2%	—
>10 to 30 MHz	+2%, −3%	—

Square-Wave Flatness—±1%, 1% p-p for both 60-Hz and 15-kHz square waves, using a 0.1-V input with Volts/Div settings between 5 and 20 mV and using a 1.0-V input with Volts/Div setting of 50 mV. Setup with 1-MΩ dc input coupling, external 50-Ω termination, Var Volts/Div in calibrated, and fast-rise input signal (rise time ≤1 ns). Exclude first 20 ns following step transition and exclude first 30 ns when 20 MHz BW LIMIT is set. For signals with rise times ≤10 ns, add 2% p-p between 155 and 165 ns after step transition.

Note: Although flatness and frequency response are verified using a 50-Ω system, similar performance can be expected when using 75-Ω systems.

Television Blanking-Level Clamp (Back-Porch) 60-Hz Rejection (Channel 2 Only)—≥18 dB at 60 Hz, with Volts/Div settings between 5 mV and 0.2 V, Var Volts/Div control set to calibrated, and a six-division reference signal.

Television Blanking-Level Clamp (Back-Porch)—Reference Within 1.0 division of ground reference.

TRIGGERING

Sync Separation—Stable sync separation from sync positive or sync negative composite video on systems with 525 to 1280 lines per frame, 50- or 60-Hz field rate, interlaced or noninterlaced scan.

Trigger Modes—Lines, Fld 1, Fld 2, and alt (Fld 1, Fld 2) coupling.

Input-Signal Amplitude for Stable Triggering Channel 1 and Channel 2—2.0 division for composite video and 0.6 division for composite sync signals (dc +peak video-signal amplitude must be within 18 divisions of input ground reference).

External 1 and External 2—60 mV division for composite video and 30 mV division for composite sync signals (dc +peak video-signal amplitude must be within 9 divisions of input ground reference).

ORDERING INFORMATION

2430A 150-MHz Digital Oscilloscope **$8,900**
Includes: Two P6133 10X, 1.3-m probes with accessories; snap accessory pouch (016-0692-00); zip lock accessory pouch (016-0537-00); 5 A, ACG/3AG, 250 V fuse (159-0014-00); blue plastic CRT filter, installed (378-0199-03); clear plastic CRT filter (378-0208-00); front cover (200-3199-01); user reference guide (070-6339-00); operator manual (070-6286-00); users GPIB interface guide (070-6338-00).
2430M 150-MHz Digital Oscilloscope with MATE/CIIL **$18,400**
Includes: Same as 2430A.

OPTIONS

Option 03—P6407 Word Recognizer Probe
A 17-bit Word Recognizer provides triggering from a variety of TTL-compatible logic families. Operable up to 20 MHz with an external clock, and up to 10 MHz without, the Word Recognizer enables the 2430A to trigger the A or B triggers on word occurrences.
Option 05—TV/Video Waveform Measurement System. **+$1,050**
Includes: Same as 2430A plus CCIR graticule CRT filter (378-0199-04); NTSC graticule CRT filter.
Option 1R—Configure scope for rackmount. **+$320**
Option 1T—Transit case. **+$185**
Option 11—Probe Power. **+$165**
Option 22—Two additional P6133 probes **+$205**

INTERNATIONAL POWER PLUG OPTIONS

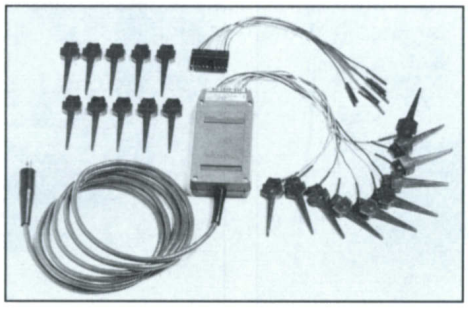
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

M1—2 Calibrations **+$240**
M2—2 Years Service **+$340**
M3—2 Years Service and 4 Calibrations **+$785**
M4—5 Calibrations **+$610**
M5—9 Calibrations +2 Years Service **+$1,430**

OPTIONAL ACCESSORIES

Service Manual—Order 070-6330-00 **$25**
Rackmount Conversion Kit—Order 016-0825-01 **$370**
Protective Cover—Blue vinyl. Order 016-0720-00 **$25**
Carrying Strap—Order 346-0199-00 **$17.50**



Input—P6407 Word Recognizer Probe, 17 bits plus clock. (No CRT display from P6407.)

All Inputs	Threshold	Load	Safe Limit
Hi	<2.0 V	<20 μA	5.5 V
Lo	>0.6 V	>−0.6 mA	−0.5 V

Display Radix—Hexadecimal, octal, binary.
Data Rate—0 to ≥20 MHz with clock, 0 to ≥10 MHz without clock.
Data Setup Time—25 ns.
Data Hold Time—0 ns.
GPIB Compatibility for Semiautomatic and Automated Measurement Systems when used in combination with 2430A Digital Oscilloscope.
P6407—Word Recognizer Probe Order 010-6407-02 **$435**
Includes: 20 grabber tips (206-0222-00); two 10-inch 10 wide comb (012-0747-00); operator's manual.

RECOMMENDED PROBES

P6230 ECL Probe **$400**
Current Probes—See Probe section.
P6021—5 ft **$450**
P6022—5 ft **$495**
A6302—2 m **$595**
A6303—2 m **$1,120**
High Voltage Probe—P6009, 100X. **$205**

OPTIONAL ACCESSORIES

HC100—Color Pen Plotter*1 **$775**
Option 01—GPIB Cable **NC**

RECOMMENDED CAMERAS

C-5C—Low-cost camera*1 **$495**
C-7—Motorized Camera*1 **$595**

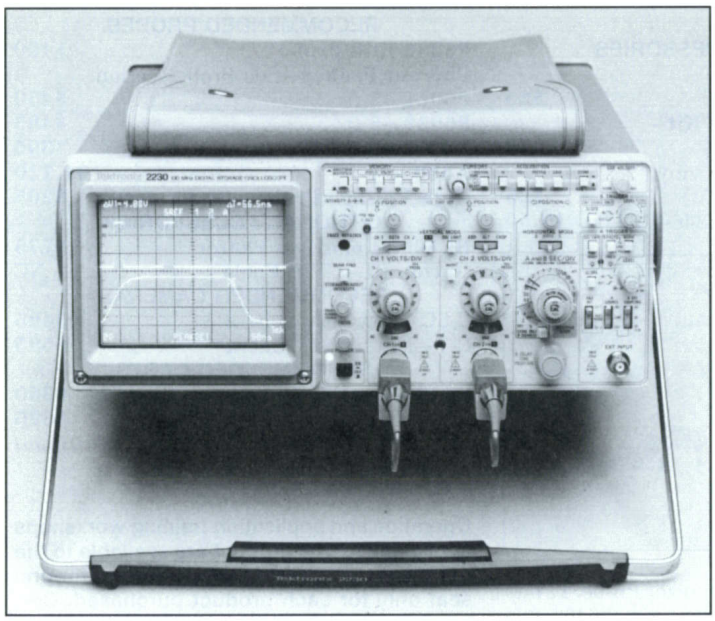
RECOMMENDED CARTS

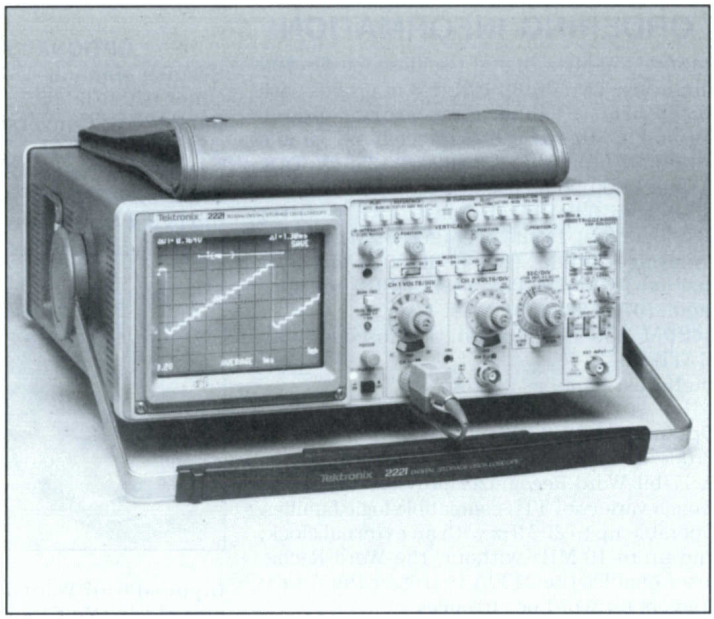
K212—Portable Instrument Cart.*1 **$350**
K213—Lab System Cart.*1 **$625**

*1 *Refer to Accessories section for additional ordering information.*

TRAINING

Operation and application training workshops applicable to this product are available to the purchaser at 50% off the normal fee, for one seat only for each product purchased. Certain other restrictions apply. Workshop content information is in Customer Training section. For further information, or to enroll, call us at 1-800-835-9433, ext. 430. In Oregon, call 1-629-1017 (collect). For international orders, contact your nearest Sales Office.





2230

- **100-MHz Digital Storage/Nonstorage**
- **100-ns Glitch Capture at Any Sweep Speed**
- **Selectable 1K or 4K Record Length**
- **Cursors for Time and Voltage Measurements**
- **Point Selectable Pre-Trigger**
- **Three Save Reference Memory Locations**
- **Expand, Compress, and Reposition Stored Waveforms**
- **GPIB or RS-232-C Optional**
- **Save Up to 26 Waveform Sets for Three Years (Option 10 or 12)**
- **UL Listed**
- **Three Year Warranty—Five Years Optional**

Analog/Digital Versatility

Now get the best of both worlds—analog and digital—with the 2230. The 2230 operates much the same way as a conventional analog scope, with the added benefit of digital storage. Switch to store mode, and powerful new capabilities are at your command. You benefit from 20 MS/s digitizing—for waveform storage and detailed analysis—plus dual time-base analog operation to 100 MHz.

Discover Digital Capabilities

With digital storage, you can capture and view events that would be difficult or impossible to see on an analog scope, such as fast transients, single-shot events, elusive glitches, and low-speed phenomena.

Acquire either a 1K or 4K record, freeze the waveform on screen, or save it in one of three reference-memory locations. For viewing of pretrigger events, point-selectable triggering allows for placing the trigger to any point on the 1K or 4K record.

Catch those elusive glitches with Tek's proprietary peak-detect mode. Glitches as narrow as 100 ns that could be missed between sample points are always captured, even at the slowest sweep speeds. Weighted signal averaging can be used to remove random noise from a signal and improve measurement accuracy.

Time-Saving Features

The 2230 includes many features that are normally found only on much more expensive products. Save-reference waveforms can be vertically expanded and repositioned, or horizontally magnified by a factor of 10. Cursors and CRT readout allow for simultaneous voltage and timing measurements. Cursor measurements can be made on save-reference waveforms as well as newly acquired waveforms. With the optional 26K of battery-backed memory, 26 waveform sets can be stored and retained—for up to three years—even if the scope's power is off.

These capabilities and more coupled with Tek's proven reliability mean you can expect outstanding value and long life from your oscilloscope investment.

2220/2221

- **60-MHz Digital Storage/Nonstorage**
- **100-ns Glitch Capture at Any Sweep Speed**
- **4K Record Length**
- **Pre/Post Triggering**
- **Pushbutton Signal Averaging (2221)**
- **Cursors and Readout for Time and Voltage Measurements (2221)**
- **Optional GPIB or RS-232-C Interface**
- **Direct Output to Printer or Plotter**
- **UL Listed**
- **Three Year Warranty—Five Years Optional**

Fast, Easy Answers

The 2220/2221 combine analog and digital capabilities in one easy-to-use product. Full-featured 60-MHz analog ability coupled with 20 MS/s digitizing provides a package that can't be beat. With the 2220/2221 in store mode, you can view pre-trigger data, "freeze" a waveform on screen, save the waveform in reference memory for later analysis and, for easy documentation, send the waveform to a printer or plotter.

Easy Event Capture and Viewing

Tek's proprietary peak-detection mode allows for the capture of glitches as narrow as 100 ns *at any sweep speed*, and the long 4K record allows for complete capture of long cycles at slow sweep speeds. With 1K displayed on screen, you can scroll through the entire 4K record, in effect getting four screens of waveform data.

Increase Productivity

The 2221 adds additional time-saving features, such as cursors and readout, that allow for faster, easier, and more accurate measurements. Pushbutton signal averaging to remove random noise and accumulate peak or envelope mode allow for viewing of signal drift or signal variations over time.

CHARACTERISTICS

The following characteristics are common to the 2230, 2221, and 2220 except where indicated.

DIGITIZER AND MEMORY

Speed—Digitizing rates from 20 MS/s at 5 μs/div and faster to 20 samples/s at 5 s/div. CHOP/ALT modes effectively halve the digitizing rate/waveform. The effective sampling rate in Repetitive Storage mode is 2 GS/s.

Useful Storage Bandwidth—Single Shot: Useful storage bandwidth is defined as the maximum sampling rate (20 MS/s) divided by the desired points/signal period. Repetitive Storage Mode: DC to 100 MHz (2230); DC to 60 MHz (2220, 2221).

Resolution—Vertical: 8 bits, 25 levels/division. Horizontal: 10 bits.

Acquisition/Process Modes—Sample, Peak Detect, Accumulated Peak Detect, Average.

Peak Detect (Enhanced Envelope) Mode—100-ns minimum pulse width for 100% probability of 50% signal amplitude capture. 10 MS/s sampling rate.

Average Mode—(2230) Normalized Average weight is selectable from $^1/_1$, $^1/_2$, $^1/_4$, $^1/_8$, $^1/_{16}$, $^1/_{32}$, $^1/_{64}$, $^1/_{128}$, $^1/_{256}$. Number of sweeps averaged is adjustable from 1 to 2047 or to an unlimited number. (2220, 2221) Average is active from 2 μs/div and faster. Normalized weight of average is $^1/_4$ for 2220, $^1/_{16}$ for 2221.

Pre/Posttrigger—(2230) $^7/_8$ (Pretrig) or $^1/_8$ (Posttrig) of waveform acquisition is prior to the trigger event. Trigger position is menu selectable over the entire record. (2220, 2221) Pretrig: $^7/_8$ of waveform-acquisition window prior to the trigger event. Posttrig: $^1/_8$ of waveform-acquisition window prior to the trigger event. Midtrig: $^1/_2$ of the waveform-acquisition window prior to the trigger event.

Record Length—(2230) 4K or 1K record length, selectable. (2220, 2221) 4K record length.

Save-Reference Memory—(2230) One 4K or three 1K acquisitions may be saved in reference memory. Options 10 and 12 offer 26K of battery backed reference memory, allowing 26 waveform sets to be saved. (2220, 2221) One 4K acquisition may be saved in reference memory.

Total Cursor Accuracy—Voltage: ±3% of delta voltage reading. Time difference is within ±[1 display interval (+1 display interval if in Acc Peak)] from 5 s to 5 μs/div and within ±[2 display intervals + (2 display intervals if in Acc Peak) +500 ps)] from 2 to 0.05 μs/div.

X-Y Plotter Output—Standard on 2230, 2221, and 2220. The oscilloscopes plot all displayed waveform(s) and readout information. The plotting of the graticule is selectable on the 2230. Plotter pen lift is adjustable with a relative speed range of 1 to 10 div/s.

External Clock—Provides an input for Ext Clock signals, dc to 1 kHz, to the storage acquisition system.

VERTICAL SYSTEM (2 Identical Channels)

Bandwidth (−3 dB) and Rise Time (Nonstore)—(2230) 100 MHz and 3.5 ns, derated to 80 MHz and 4.4 ns at 2 mV/div and outside 0 to +35°C. (2220, 2221) 60 MHz and 5.8 ns, derated to 50 MHz and 7.0 ns at 2 mV/div and outside 0 to +35°C.

Bandwidth Limit—(2230) 20 MHz ±10%. (2220, 2221) 10 MHz ±15%.

Nonstore Deflection Factor and Accuracy—2 mV to 5 V/div 1-2-5 sequence, accuracy is ±2% (0 to +35°C). Uncalibrated: Continuously variable between steps to at least 2.5:1.

Store Deflection Factor and Accuracy—2 mV to 5 V/div. Displayed signal amplitude is within ±3% of the input voltage over the dynamic range of the A/D converter.

Vertical System Operating Modes—CH 1, CH 2, CH 2 Invert, ADD, ALT, CHOP (500 kHz nonstore).

Common-Mode Rejection Ratio—For signals of 6 div or less, at least 10:1 (at 50 MHz).

Input R and C—1 MΩ, 20 pF.

Maximum Input Voltage (AC and DC Coupled)—400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

Channel 1/Channel 2 Isolation—100:1 at 50 MHz.

AC-Coupled Lower Cutoff Frequency—10 Hz or less at −3 dB.

Automatic Scale Factor—(2230, 2221) Probe tip deflection factors for coded probes are automatically indicated in the CRT readout.

HORIZONTAL SYSTEM

A Time Base—0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div. In Store mode, lower sweep speed is extended to 5 s/div.

B Time Base—(2230) 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div.

Variable Sec/Div Control—In Nonstorage mode, uncalibrated variable extends sweeps by at least 2.5:1. In storage mode, a 4K acquisition is compressed to 1K for on-screen viewing.

Sweep Linearity—±5% over any two of the center eight divisions.

Time-Base Accuracy—Storage mode: 0.1% over full 10 cm (or div).

Nonstorage Mode	+15 to +35°C	0 to +50°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Operating Modes—(2230) Nonstorage: A, Alternate with A intensified by B, and B; Storage: A, A intensified by B, and B.

DELAYED SWEEP (2230)

Delayed Sweep Delay Times—Continuously variable with 10-turn control from less than 0.5 div plus 300 ns to greater than 10 div.

Differential Delay Time Accuracy—±1% (0 to +35°C, ±2% (0 to +50°C).

Delay Jitter—5,000:1 (0.02%), nonstore mode only.

TRIGGERING

A Trigger Sensitivity

2230	Internal	External
10 MHz	0.35 div	40 mV
100 MHz	1.5 div	200 mV
2220/2221	**Internal**	**External**
5 MHz	0.3 div	40 mV
60 MHz	1.0 div	120 mV

B Trigger (Internal Only)—Sensitivity (2230) 0.35 div at 10 MHz, 1.5 div at 100 MHz.

Trigger System Operating Modes—Normal, P-P Automatic, TV Line, TV Field, and Single Sweep. HF Rej triggering attenuates signals above 40 kHz. Lowest usable frequency for P-P Automatic is 20 Hz.

Trigger Coupling—Automatic coupling with internal signal sources: AC with P-P Automatic and TV Field; DC with Normal and Single Sweep.

Trigger Sources—A trigger: Internal, external, and line. B trigger (2230): Internal only.

External Trigger Input—Input Coupling: AC, dc, or dc divide by 10. Bandwidth: 100 MHz (2230), 60 MHz (2220, 2221); ac-coupled lower cutoff frequency is 10 Hz or less at −3 dB. Maximum safe input voltage same as scope's vertical channels.

X-Y MEASUREMENTS

Deflection Factors—Same as scope's vertical system with the Volts/Div switch in calibrated detent.

Accuracy—Storage Mode is same as digital storage vertical-deflection system.

2230 Nonstorage	Y-Axis	X-Axis
+15 to +35°C	±2%	±3%
0 to +50°C	±3%	±4%

Storage-Mode Bandwidth—(2230) dc to 100 MHz. (2220, 2221) dc to 60 MHz. Bandwidth changes proportionate to sweep speed.

Nonstorage Bandwidth—Y-axis same as scope's vertical system, X-axis: 3.0 MHz.
Nonstorage Phase Difference—Between X and Y amplifiers: ±3° from dc to 150 kHz.
Storage-Mode Phase Difference—Time difference between Y-axis and X axis is no more than 100 ns. The X-axis is sampled before the Y-axis. Between X and Y amplifiers: Less than ±2° referenced to a 10-division signal period.

CRT AND DISPLAY FEATURES

CRT—8×10 cm display; internal graticule, nonilluminated, accelerating potential is 14 kV, GH (P31) phosphor standard.
Controls—Beam finder, focus, trace rotation. (2230) Storage/Readout intensity, separate A and B sweep intensity.
Z-Axis—Sensitivity: 5 V causes noticeable modulation, positive voltage decreases intensity. Usable frequency range is dc to 20 MHz. Maximum safe input voltage is 30 V (dc + peak ac) or 10 V ac p-p at 1 kHz or less. Input resistance is approximately 10 kΩ.

OTHER CHARACTERISTICS

Probe Adjustment Signal—0.5 V ±5% square wave at 1 kHz ±20%.

POWER REQUIREMENTS

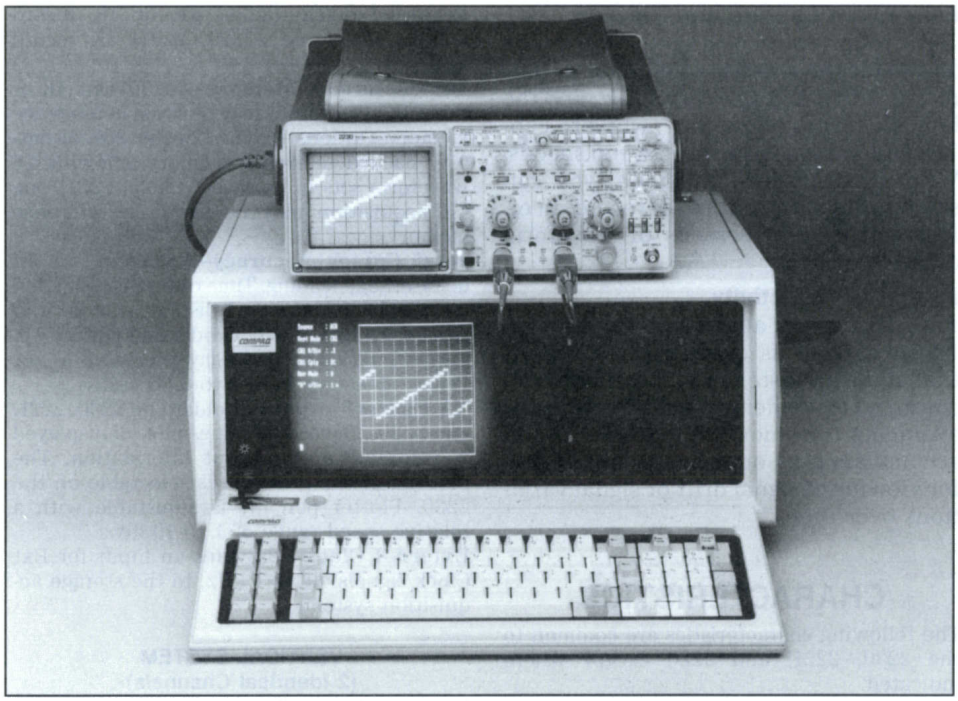
Line-Voltage Range—90 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—85 W, 2.0 A, at 250 V (slow blow).

ENVIRONMENTAL

Temperature—Operating: 0 to +50°C; Nonoperating: −55 to +75°C.
Altitude—Operating: to 4 500 meters (15,000 ft), maximum operating temperature decreased 1°C per 1,000 ft above 5,000 ft. Nonoperating: to 15 000 m (50,000 ft).
Humidity—Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C, for Type III, Class 5 instruments.
Radiated and Conducted Emissions—Requirements per VDE-0871. Meets Class B.
Vibration—Operating: 15 minutes along each of three axes at a total displacement of 0.015-inch p-p (2.4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one-minute sweeps; hold for 10 minutes at 55 Hz in each axis; all major resonances must be above 55 Hz.
Shock—Operating and Nonoperating: 30 g's, half-sine, 11-ms duration, 3 shocks per axis for a total of 18 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width		
w/handle	360	14.2
w/o handle	328	12.9
Height, w/feet & handle	137	5.4
Depth		
w/front cover	445	17.5
w/front cover	440	17.3
w/front cover	511	20.1
Weight ≈	**kg**	**lb**
Net, w/o cover, accessories, & pouch	8.3	18.0



Option 10 GPIB Interface
Option 12 RS-232C Interface

GPIB IEEE-488

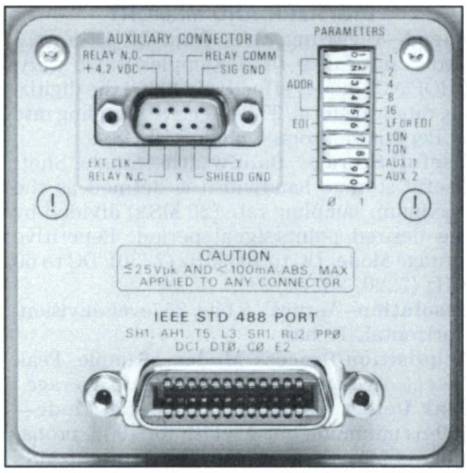
With Option 10, the 2230/2221/2220 comply with IEEE Standard 488-1978 and use Tektronix *Standard Codes and Formats*. With Option 12, the 2230/2221/2220 feature Standard RS-232C and use an extension of Tektronix *Standard Codes and Formats*.

GPIB (Option 10) and RS-232C (Option 12) interfaces are available for the 2230, 2221, and 2220. Either interface can transmit and receive waveform data. Most front-panel settings can be queried and many functions can be controlled via the interface; e.g., single-sweep reset.

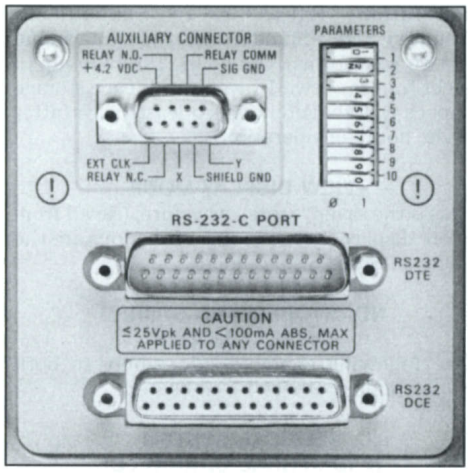
2230 and 2221 Option 10 or 12 interfaces also allow messages or computed results to be displayed on screen. The 2230 includes a battery-backed reference memory (minimum lifetime 3 years) for storage of up to 26 additional waveform sets.

The Option 10 GPIB interface conforms to IEEE Standard 488-1978. It is fully compatible with Tektronix *Standard Codes and Formats*. Primary address (0-30), message terminator (EOI or LF/EOI), and talk/listen mode are selected by a switch on the oscilloscope side panel. Maskable interrupts for RQS and OPC can be programmed.

IEEE Standard 488-1978 Interface Function Subsets Implemented—SHI, AHI, T6, L3, SRI, RL2, PP0, DCI, DT0, C0.



Option 10 GPIB Interface

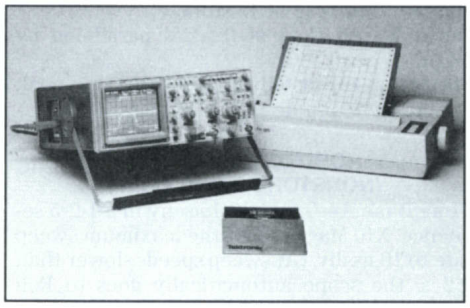


Option 12 RS-232C Interface

The Option 12 RS-232C interface has both DCE and DTE connectors. It is compatible with an extension of Tektronix *Standard Codes and Formats*. Baud rate (50–4800), parity (Odd, Even, Mark, Space, or none), line termination (CR or CR-LF), and SRQ generation on parity error (ON or OFF) are selected by a switch on the oscilloscope side panel. Number of bits per character (7 or 8), number of stop bits (1 or 2), and CTRL-S/CTRL-Q handshaking (enable/disable) may be changed by remote commands. The interface automatically senses the presence of Clear to Send (CTS)/Request to Send (RTS) or Data Set Ready (DSR)/Data Terminal Ready (DTR) handshaking lines.

Option 12 for the 2230 also includes 26K of battery-backed reference memory for the storage of up to 26 waveform sets.

Direct Connection to Printers and Plotters via GPIB or RS-232C.



A 2230, 2221, or 2220 equipped with either Option 10 or Option 12 interface is fully compatible with any Digital X-Y plotter that uses Hewlett-Packard Graphics Language (HPGL). The GPIB interface is also compatible with the HC100 Color Pen Plotter. The RS-232C interface also supports the HC100 Opt. 01 Color Pen Plotter, any Epson FX-Series format printer, or the HP Thinkjet 2225D printer. Plotter output is directed to the interface if its control switches are set for the appropriate plotter or printer. Otherwise, plotting is directed to the X-Y outputs.

ORDERING INFORMATION

2230—100-MHz Dual Time Base Digital-Storage Oscilloscope **$4,995**
Includes: Two P6121 10X voltage probes, front-panel cover (200-2520-00), accessory pouch (016-0677-02), operator manual (070-4998-01), user's reference card (070-5370-00).

2221—60-MHz Single Time Base Digital-Storage Oscilloscope **$3,995**
Includes: Two P6121 10X voltage probes, pouch (016-067-02), operator manual (070-5301-01), user's reference card (070-6532-00).

2220—60-MHz Single Time Base Digital-Storage Oscilloscope **$2,995**
Includes: Two P6122 10X voltage probes, front-panel cover (200-2520-00), accessory pouch (016-0677-02), operator manual (070-5301-00), user's reference card (070-5681-00).

OPTIONS

Option 10—(2230) GPIB IEEE-488 Interface. **+$750**
Includes: 26K of Battery-Backed Reference Memory.
Option 12—(2230) RS-232C Interface **+$750**
Includes: 26K of Battery-Backed Reference Memory.
Option 10—(2220, 2221) GPIB IEEE-488 Interface. **+$500**
Option 12—(2220, 2221) RS-232C Interface. **+$500**
Option 33—Travel Line Package. See Portable Oscilloscopes section. **+$245**

FIELD RETROFIT KITS

2230F10—Field Retrofit Kit for Option 10. **$750**
2230F12—Field Retrofit Kit for Option 12. **$750**
2221F10—Field Retrofit Kit for Option 10. **$500**
2221F12—Field Retrofit Kit for Option 12. **$500**
2220F10—Field Retrofit Kit for Option 10. **$500**
2220F12—Field Retrofit Kit for Option 12. **$500**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

M1—(2230) 2 Calibrations. **+$215**
M1—(2221) 2 Calibrations. **+$210**
M1—(2220) 2 Calibrations. **+$205**
M2—(2230) + 2 Years Service. **+$250**
M2—(2221) + 2 Years Service. **+$245**
M2—(2220) + 2 Years Service. **+$235**
M3—(2230) 4 Calibrations & 2 Years Service. **+$640**
M3—(2221) 4 Calibrations & 2 Years Service. **+$630**
M3—(2220) 4 Calibrations & 2 Years Service. **+$610**
M4—(2230) 5 Calibrations. **+$555**
M4—(2221) 5 Calibrations. **+$545**
M4—(2220) 5 Calibrations. **+$535**
M5—(2230) 9 Calibrations & 2 Years Service. **+$1,240**
M5—(2221) 9 Calibrations & 2 Years Service. **+$1,210**
M5—(2220) 9 Calibrations & 2 Years Service. **+$1,185**

OPTIONAL ACCESSORIES

HC100—Color Pen Plotter **$775**
Option 01—GPIB Cable **NC**
Service Manuals—
(2230) Order 070-4999-00 **$25**
(2221) Order 070-6531-00 **$25**
(2220) Order 070-5302-00 **$25**
Rackmount Adapter Kit—
Order 016-1003-00 **$130**
Carrying Strap—Order 346-0199-00 **$17.50**
Carrying Case—Order 016-0792-01 **$360**
Rain Cover—Order 016-0848-00 **$15.25**
Viewing Hoods—
(Binocular) Order 016-0566-00 **$19**
(Collapsible) Order 016-0592-00 **$14.25**
(Polarized) Order 016-0180-00 **$60**
A6902B Isolator—For floating measurements. See Accessories section for complete description. **$1,885**
CRT Light Filter—
(Clear) Order 337-2775-01 **$1.95**
1107 DC Inverter—See Portable Oscilloscopes section. **$1,140**
1107 Mounting Kit—
Order 016-0785-00 **$55**

RECOMMENDED PROBES

P6062B—1X/10X probe **$175**
See Probe section for additional probes.
Current Probes—A6302/AM 503. **$1,780**

RECOMMENDED CART

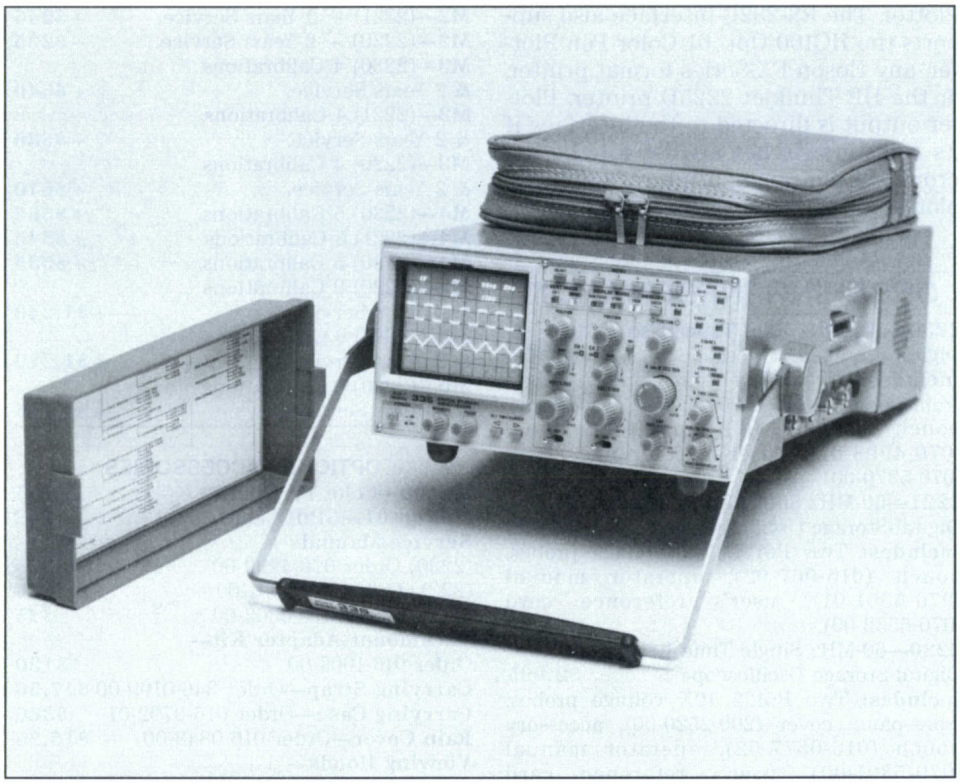
K212—Portable Instrument Cart. **$350**

RECOMMENDED CAMERAS

C-5C Option 04—See Camera section. **$495**
C-7 Option 02—See Camera section. **$565**
C-30BP/Option 01—See Camera section. **$1,548**

TRAINING

Operation and application training workshops applicable to this product are available to the purchaser at 50% off the normal fee, for one seat only for each product purchased. Certain other restrictions apply. Workshop content information is given in the Customer Training section. For further information, or to enroll, call us at 1-800-835-9433 ext. 430. In Oregon, call 1-629-1017 (collect). For international orders, contact your nearest Sales Office.



336

GPIB IEEE-488 — The 336 with Option 01 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

- **1 MS/s, 140-kHz Useful Storage Bandwidth**
- **Cursors for Time and Voltage Measurements**
- **Signal Averaging**
- **Envelope Mode**
- **GPIB and Eight-Screen Memory Option (16K)**
- **50-MHz Nonstorage Bandwidth**
- **CRT Readout**

TYPICAL APPLICATIONS

Medical Systems
Communication-Equipment Service
Electronic Design
X-Ray Equipment Maintenance

See Portable Oscilloscopes Reference section for available Application Notes.

The SONY®/TEKTRONIX® 336 is a combination nonstorage and digital-storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor-controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hardwired front-panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division which allows "hands off" operation in many applications.

The 336 has a dual-channel, dc to 50-MHz vertical-deflection system for both nonstorage and equivalent-time digitizing. Storage bandwidth for single-sweep events (waveforms acquired as the result of a single triggering event) is dc to 140 kHz. The vertical channels have calibrated deflection factors from 5 mV to 10 V per division with a choice of either ac or dc input coupling. In the Nonstore mode, the 336 operates like a conventional oscilloscope.

GPIB (talker only) is optional on the 336. Included in the option is a memory backup of up to eight screens (two 1K waveforms each) of information.

CHARACTERISTICS

DIGITIZER AND MEMORY

Speed—Digitizing rates up to 1 megasample/s.
Useful Storage Bandwidth—Real-Time Sampling: DC to 140 kHz (−3 dB). Equivalent-Time Sampling: DC to 50 MHz (−3 dB).
Resolution—Vertical: 8-bit. Horizontal: 10-bit.
Memory Size—Standard: 2K byte (one frame of two waveforms). Option 01: 16K byte (up to eight frames of two 1K waveforms each storage capacity). Data Retention: At least 3 days (after eight hours of operation).

VIEW DISPLAY MODE

This is the saved "store" waveform (saved from Store display mode). Process functions are the same as Store display mode.

NONSTORED AND STORED DISPLAY MODES

The following characteristics apply to both modes unless otherwise indicated.

VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

Bandwidth and Rise Time*[1]

0 to +40°C	+40 to +55°C
DC to at least 50 MHz	DC to at least 40 MHz

*[1] *At all deflection factors from a 50-Ω source.*

Deflection Factor—Range: 5 mV to 10 V/div. Accuracy is ±3%. Uncalibrated, continuously variable between steps, and to at least 25 V/div.
Vertical Modes—Stored Mode: CH 1, CH 2, Chop, Dual and Trigger View. Nonstored Mode: CH 1, CH 2, Chop and Dual.
Normal Mode (Store Mode Only)—Acquired displayed signal.
Envelope Mode (Store Mode Only)—1, 8, 16, 32, 64, 128, 256 sweeps, or continuous at s/div settings of 2 ms to 0.2 s/div.
Average Mode (Store Mode Only)—8, 16, 32, 64, 128 or 256 sweep averages.
Process Mode (Store and View Mode Only)—Waveform: CH 1 + CH 2 is within 6%. CH 1—CH 2 is within 6%. CH 1 × CH 2 is within 7%. Parameters (Selectable): RMS is within 3% + 6% of V/div setting. Mean is within 3% + 4% of V/div setting. P-P is within 3% + 4% of V/div setting. Store or view waveforms must acquire initial ground-reference level.
Common-Mode Rejection Ratio—At least 10:1 at 10 MHz (5-MHz storage).
Input R and C—1 M Ω ±2% paralleled by 33 pF.
Maximum Input Voltage—200 V (dc + peak ac) or 200 V p-p ac to 1 kHz.

HORIZONTAL SYSTEM (NONSTORE MODE ONLY)

Time Base A—0.2 s to 0.1 μs/div in a 1-2-5 sequence. X10 Mag extends the maximum sweep rate to 10 ns/div. (At sweep speeds slower than 0.2 s, the scope automatically goes to Roll mode.)
Time Base B—50 ms to 0.1 μs/div in a 1-2-5 sequence. X10 Mag extends the maximum sweep rate to 10 ns/div.
Variable Time Control—Continuously variable between calibrated settings of the A s/div switch. Extends the slowest sweep rate to at least 0.5 s/div.

Time Base Accuracy

	+20 to +30°C	0 to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

DIGITAL STORAGE HORIZONTAL ACQUISITION

Resolution—Ten bit. 1024 data points.
Range—Equivalent-Time Sampling: 50 ns to 0.1 ms/div. Single-Sweep Storage: 0.2 s to 0.1 ms/div. Roll Mode: 20 to 0.5 s/div. Envelope Mode: 0.2 s to 2 ms/div.
Accuracy—3% from +20 to +30°C; 4% from 0 to +55°C.
Horizontal Display Modes—Nonstore: A sweep, B delay, alternate, X-Y. Storage: A sweep, B delay, X-Y.

CALIBRATED SWEEP DELAY

Differential Time Measurement Accuracy (Nonstore Mode)

+15 to +35°C	Within 1% of indicated value
0 to +55°C	Within 2.5% of indicated value

Delay Time Jitter (Nonstore Mode)—≤1 part in 10,000.
Delay Time Resolution (Store Mode)—14-bit.
Cursor Accuracy (Store Mode)—ΔV: Within 3%. ΔT: Real-time sampling is ±0.1% of full scale. Equivalent-time sampling from +20 to +30°C is ±3%; from 0 to +55°C is ±4%.

TRIGGERING A AND B

A Trigger Modes—Normal: Sweep generator requires a trigger to generate a sweep. Automatic: Sweep generator free runs in the absence of a trigger. Single sweep: One sweep is initiated by the first trigger after reset.
Trigger Sources—Internal, CH 1, CH 2, composite, or external.

Sensitivity and Coupling

Coupling	To 10 MHz	To 50 MHz
AC	0.3 div above 30 Hz	1.5 div
LF Rej	0.5 div above 50 kHz	1.5 div
HF Rej	0.5 div, 30 Hz to 50 kHz	—
DC	0.3 div	1.5 div
External	70 mV	350 mV
TV	Stable video rejection and sync separation from sync-negative NTSC or PAL composite video	

Trigger Jitter—Nonstore Mode: 1 ns or less at 50 MHz. Storage Mode: ±1 sample period.
External Trigger View—Deflection Factor: Ext is 100 mV/div. Ext÷10 is 1 V/div.
External Trigger Input—R and C=1 M Ω paralleled by 33 pF. 200 V (dc + peak ac) maximum input.
Acquisition-Window Trigger Point—Pretrigger: 7/8 of waveform occurs before trigger point. Midtrigger: 1/2 of waveform occurs before trigger point. Posttrigger: 1/8 of waveform occurs before trigger point.

X-Y OPERATION (NONSTORE)

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)—5 mV to 5 V/div with bandwidth of dc to 1 MHz. Phase difference is 3° from dc to 50 kHz.

CRT AND DISPLAY FEATURES

CRT—8×10 div (0.6 cm/div) display, GH (P31) phosphor. 12 kV operating potential.
Graticule—Internal. Vertical and horizontal centerlines marked in 5 minor div/major 0.6 cm/div.
Z-Axis Input—Range +3 to +25 V with 1-MHz usable frequency range. Input resistance of at least 10 kΩ.

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +55°C. Nonoperating: −25 to +75°C. Option 01: −20 to +55°C.
Altitude—Operating: To 4600 m (15,000 ft). Decrease maximum operating temperatures 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).
Vibration—0.025 p-p (4 g's at 55 Hz) displacement, 15 minutes along each axis from 10 to 55 Hz.
Humidity—120 hrs of MIL-STD-202D, method 106°C, minus freezing and vibration.
Shock—30 g's half sine, 11-ms duration on each axis.

OTHER CHARACTERISTICS

Chart Output—Clock Rate: Fast or slow. Amplitude: 500 mV/div. Output Impedance: 220 Ω.
Calibrator—Output Voltage: 0.3 V ±1%. Output Resistance: 50 Ω. Frequency: ≈1 kHz.
AC Power Requirements—Line-Voltage Ranges: 90 to 132 V ac, 180 to 250 V ac. Line Frequency: 48 to 440 Hz. Power Consumption: 50 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	237	9.3
Height	112	4.4
Depth		
Handle Not Extended	370	14.6
Handle Extended	482	19.0
Weight ≈	**kg**	**lb**
Net	5.0	11.1
Shipping	10.5	23.1

GPIB IEEE-488 Option 01

GPIB Interface/Extended Memory

Option 01 GPIB Interface/Extended Memory Option 01 provides a GPIB interface (talk only) and extended memory. The GPIB interface transfers waveforms and scale-factor information to a listener or controller. 16K total extended memory stores 16 additional waveforms at 2 waveforms per screen. The HC100 Color Plotter will provide hardcopies of the display.
IEEE Standard 488-1978 Interface Function Subsets Implemented— SH1, AH1, T1, L0, SR1, RL0, DC2, DT0, PP0, C0.

ORDERING INFORMATION

336 Digital-Storage Portable Oscilloscope **$5,470**
Includes: Two 10X P6148A attenuator probes; accessory pouch (016-0718-00); front-panel cover (016-0719-00); CRT filter (378-0225-00); operator manual (070-4421-00); and service manual (070-4420-00).
Option 01—GPIB Interface/Extended Memory. **+$875**

OPTIONAL ACCESSORIES
(See Accessories section.)

HC100 Plotter—Works through GPIB. **$775**
Option 01—GPIB Cable **$NC**

RECOMMENDED PROBES

P6148A—10X Probe. Order 010-6148-13 **$130**
A6303—Current Probe. **$1,120**
AM 503—Current Probe Amplifier. **$1,185**

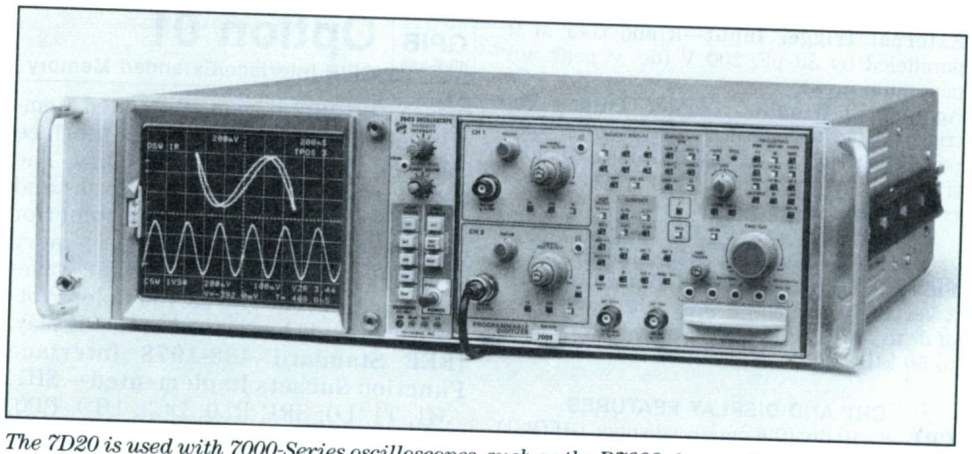
RECOMMENDED CAMERA

C-30BP Option 01 **$1,548**
Camera Mounting Adapter—Order 016-0327-01 **$175**

RECOMMENDED CART

K212—For on-site mobility. **$350**

The SONY®/TEKTRONIX® 336 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 336 is available from Tektronix, Inc., its marketing subsidiaries, and distributors.



The 7D20 is used with 7000-Series oscilloscopes, such as the R7603 shown above in a rackmount configuration. See 7000-Series Instruments for details.

7D20

GPIB IEEE-488 The 7D20 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Digital Storage for 7000-Series Mainframe**
- **70-MHz Bandwidth for Repetitive Signals**
- **10-MHz Single-Shot Bandwidth**
- **Two Channels Simultaneous Acquisition**
- **Totally Programmable**
- **Storage of Six Independent Waveforms**
- **Enveloping and Signal Averaging**
- **Cursor Measurements**
- **Pretrigger and Posttrigger**

TYPICAL APPLICATIONS

Ultrasonics
Digital Design
RF Modulation
Automated Production Testing

See 7000-Series Instruments for available Application Notes.

The 7D20 is a GPIB programmable plug-in compatible with all 7000-Series mainframes (including the USM 281C) except the 7104. With a 7000-Series mainframe, it creates a fully programmable, digitizing oscilloscope.

The 7D20 accurately measures amplitudes of 50-ns-wide transient events. Dual samplers simultaneously acquire two channels like a "dual beam" scope.

The 7D20 offers signal averaging to reduce uncorrelated noise, envelope displays to compare dynamic characteristics of changing signals, pretrigger for viewing prior to the trigger event, storage of six independent waveforms plus a reference waveform, cursors for more accurate two-dot measurements, and user prompting and menu displays to improve user-interface effectiveness.

Digital Storage

40-MHz maximum sampling rate provides approximately 10-MHz single-shot bandwidth and up to 70-MHz bandwidth with repetitive signals.

Storage and Recall Front-Panel Settings

Up to six different front-panel set-ups can be stored and recalled. These settings, plus the last panel set-up, are saved in nonvolatile memory and are restored automatically when power is applied.

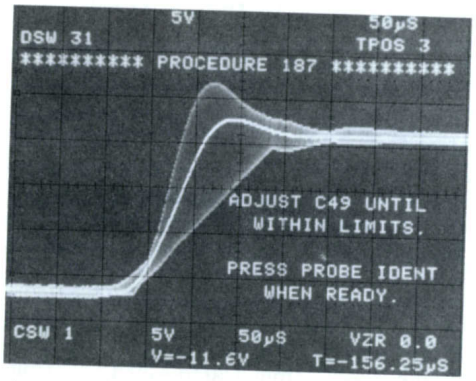
Fully Automated Measurements

Since the 7D20 is completely programmable, fully automated measurement and testing is possible. Tektronix programmable signal sources, multifunction interface, and RF scanner provide and control the test signals while the 7D20 acquires waveforms for the computer or controller.

TekMAP Software Support

For the Tek 4041, IBM PC, or HP Series 200 computers, Tektronix Measurement and Application Programs (TekMAP) tap the full potential of the 7D20. The 7D20/Tek 4041 software package supports the 7D20 when used in conjunction with the Tek 4041 Controller. It provides automated pulse-parameter analysis and storage and retrieval of waveforms on DC-100 tape. Data results are available in graphic or tabular form.

The 7D20/HP Series 200 software package supports the 7D20 when used with the HP Series 200 (216, 226, 236) Technical Computers. It provides automated pulse-parameter analysis, propagation-delay measurements, FFT, and storage and retrieval of front-panel settings and waveforms. Data results are available in graphic or tabular form.



Automated Testing

Interactive test procedures, text messages, waveforms, and front-panel set-ups may be transmitted and received from the 7D20 to a controller or computer. This envelope was initially constructed using the 7D20's envelope feature while a test signal was varied to its allowable limits. The waveform was then transferred and saved by the controller to serve as the test reference or overlay.

CHARACTERISTICS

VERTICAL SYSTEM

Input—Two channels, simultaneous sampling, BNC connectors.
Acquire Modes—CH 1, CH 2, Add, Both (dual channel).
Sensitivity—5 mV to 5 V/div; 1-2-5 sequence.
Bandwidth—70 MHz maximum. (AC-Coupled Low-Frequency Response: 10 Hz or less.)
Step Response—5 ns or less.
Input Impedance—1 MΩ paralleled by ≈20 pF.
Maximum Input Voltage—DC Coupled: 250 V, 1 kHz or less (dc + peak ac). AC Coupled: 400 V, 1 kHz or less (dc + peak ac).
Signal Isolation—100:1 dc to 20 MHz.
Vertical Resolution—8 bits, 256 levels, 0.04 div/level.
Gain Ratio Accuracy—<2%. Maximum error throughout the V/div range with acquire gain calibrated at 10 mV/div. Measurement valid with Cursors or GPIB.
Noise—Mean value of 50 measurements taken at 0.02-div increments.

Volts/Div	Full Scale*1/ RMS Noise	% of Full Scale*1
5 mV	52 dB	0.25
10 mV to 5 V	55 dB	0.18

*1 *Full scale=10.24 divisions.*

Phase Match X-Y—<2° from dc to 10 MHz.

HORIZONTAL SYSTEM

Time/Division Range—External Clock, 20 s to 50 ns/div in 1-2-5 sequence.
Digitizing Technique vs Time/Division—Real Time (Rolling Display): External Clock, 20 to 0.1 s/div. Real Time: 50 ms to 500 µs/div. Extended Real Time: 200 to 2 µs/div. Equivalent Time: 1 µs to 50 ns/div.

Note: Single events can be captured as fast as 2 µs/div. For 1 µs to 50 ns/div, repetitive events are required to build a complete waveform.

Time-Measurement Accuracy—One Cursor: 0.1% of reading +0, −1 sample interval ±300 ps. Two Cursors: 0.1% of reading ±600 ps.

Horizontal Resolution

Time/Division	Points/ Waveform	Resolution Points/ Division
External, 20 s to 500 μs	1024	100
200 to 2 μs	820*1	80*1
1 μs to 50 ns	1024	100

*1 *Waveform interpolation to 1024 points is available for transfer over the GPIB Interface.*

Trigger Position
Pretrigger: 0 to 10 div in 1-div increments. Posttrigger (delay): 0 to 1500 div in 1-div increments (disabled during Roll with Envelope or Average).

HMAG ALL (Horizontally Magnify All Waveforms): Displays all waveforms at 10 times horizontal magnification.
VS (Versus): Creates a Y versus X display of any two waveforms.

GPIB INTERFACE

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T5	Complete talker—no secondary address
L3	Complete listener—no secondary address
SR1	Complete service request
RL1	Complete remote local
DC1	Complete device clear
DT1	Complete device trigger
PP0	No paralle poll
C0	No controller
E2	Three state

	Frequency Range*1	Sensitivity Internal	Sensitivity External
Normal (DC Coupling)	DC to 30 MHz	0.4 div	60 mV
	30 to 70 MHz	1.0 div	150 mV
P-P and Auto	30 to 200 Hz	2.0 div	300 mV
	200 Hz to 30 MHz	0.6 div	90 mV
	30 to 70 MHz	1.2 div	200 mV

*1 *The ac-coupling low-frequency limit is 30 Hz. In Time/ Div settings of 1 μs to 50 ns, when using P-P or Auto, low-frequency limit is 300 Hz.*

SIGNAL PROCESSING

Cursors Readout—With one cursor (ΔOff), vertical and horizontal coordinate values are referenced to zero volts and the trigger position as zero time. With two cursors (ΔOn), vertical and horizontal coordinate values are the difference between the two cursors.

Signal Averaging
AVE N: A self-terminating, stable average processes "N" number of waveforms and then holds the result in memory. The "N" value may be selected using the SET N function (N=8, 16, 32, 64, 128, 256).
AVE: A continuous, stable averaging process. N waveforms are averaged as in AVE N, then additional waveforms are weighted at 1/N. In Roll mode, a running average (smooth) is available to provide high-frequency filtering.

Enveloping
ENV N: A self-terminating recording of waveform maxima and minima. When N waveforms are processed, the result is held in memory.
ENV: A continuous (infinite) recording of waveform maxima and minima.

Waveform Modifiers
VPUP ↑ (Vertical Position Up), VPDN ↓ (Vertical Position Down): Provide vertical positioning control of any stored waveforms.
VCMP ⫲ (Vertically Compress), VXPD ↕ (Vertically Expand): Provide vertical display expansion or compression. Two expansions or compressions in 1-2-5 calibrated steps from the original V/div are available.
HMAG (Horizontal Magnify): Displays the cursor waveform horizontally magnified by a factor of 10.

Programmable Functions—All instrument settings and operating modes are programmable except for Variable V/div and Horizontal Position. However, these uncalibrated controls can be overridden and forced into the "CAL" position on command from the GPIB Interface. The display of Menu and ID is selectable from the front panel only.
Format—Device-dependent commands in ASCII. Waveform data points selectable as BINARY or ASCII.
Waveform Output Time—250 ms minimum for BINARY and 2.5 s minimum for ASCII. Actual transfer times depend upon the speed of the receiving device.

INPUTS

External Trigger (Front Panel)—Maximum Input Voltage: 250 V (dc + peak ac).
Signal Input Impedance—1 MΩ, paralleled by ≈20 pF.
Hold Next (Mainframe Rear Panel)—Initiates Hold Next condition; connected to Single-Sweep Reset connector.

OUTPUTS

Hold Next Ready—High level indicates unit is in Hold Next condition; output level remains low when unit is not in Hold Next condition; connected to Single-Sweep Ready connector.
+Gate Out—Provides high-level output signal for duration of waveform/character readout.

PLUG-IN COMPATIBILITY

The 7D20 is compatible with all 7000-Series mainframes with the exception of the 7104. Use with the 7104 will void the 7104 warranty.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	206	8.1
Height	127	5.0
Depth	371	14.6
Weight ≈	**kg**	**lb**
Net	3.6	8.1
Shipping	8.0	17.8

ORDERING INFORMATION

7D20 Programmable Digitizer (Plug-In) **$7,590**
Includes: Instruction manual (070-3857-01); pocket reference guide (070-3205-01).

TekMAP SOFTWARE

S42P201 7D20/IBM PC Software **$450**
Includes: Operator manual.
Option 01—5¼ in. double-sided, dual density. **NC**
S42H201 7D20/HP Series 200 Software **$950**
Includes: Operator manual.
Option 01—5¼ in. double-sided, dual density. **NC**
Option 02—3½ in. double-sided, dual density. **NC**
7D20/Tek 4041 Software DC-100 Tape. Order 062-7732-00 **$150**
Includes: Operator manual.

UTILITY SOFTWARE

(7D20/4041) Order 062-6959-01 **$150**
(7D20/4052A) Order 062-6961-01 **$150**
See System Support for description and ordering information.

RECOMMENDED PROBE

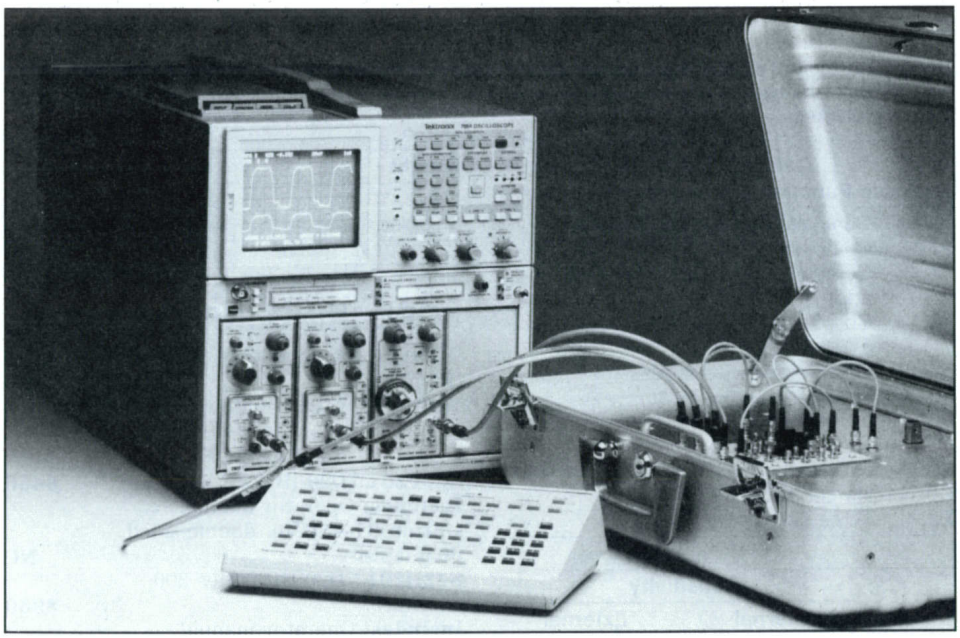
P6053B Identify Probe For remote service request via probes "Identify" button. 10X attenuation; 200-MHz bandwidth; scale factor coding; 6 ft. **$150**

RECOMMENDED MAINFRAME FOR 7D20

R7603 Option 20—The R7603 mainframe provides a 6-inch diagonal CRT display and three-wide plug-in compartment in a 5¼-inch-high rackmount configuration. Option 20 permits rear-panel access to the 7D20's GPIB Interface and includes cable 175-7151-00 required inside 7D20. **$4,910**

OPTIONAL ACCESSORIES

R7603 Field Kit—Adds Option 20 to a previously purchased standard R7603. This kit provides parts to connect the 7D20's GPIB Interface to the R7603 mainframe.
Order 040-1093-00*1
HC100 Plotter—See Accessories section. **$775**



7854

GPIB IEEE-488 The 7854 is designed to support other products that comply with IEEE Standard 488-1975.

- **Waveform Parameters at the Touch of a Key**
- **DC to 400-MHz Real-Time Bandwidth at 10 mV/Div**
- **Calibrated Sweep Rates to 500 ps/Div**
- **Stores Repetitive Waveforms Up to 14 GHz With Sampling Plug-Ins**
- **Signal Averaging**
- **Resolution Up to 0.01 Div on Stored Data (10-Bits)**
- **Choose 128, 256, 512, 1024 Points/Waveform**
- **Keystroke Programming**

TYPICAL APPLICATIONS

Power-Supply Switching
Semiconductors
Fiber Optics

See 7000-Series Reference section for available Application Notes.

The 7854 Waveform-Processing Oscilloscope combines the features of a high-performance real-time oscilloscope with digital storage and waveform processing. When integrated with any of a wide variety of 7000-Series plug-ins, it becomes a powerful measurement system. The 7854 offers programmable measurement routines, GPIB interface for mass data and program storage, plus simultaneous display of real-time and stored waveforms. The 7854's on-board memory stores up to 40 waveforms and 2000 keystrokes.

Mainframe and calculator keyboard functions provide cursor control and waveform-parameter information at the touch of a button, e.g., maximum, minimum, peak-to-peak, risetime. Additional calculator-keyboard features enable arithmetic manipulation of waveforms such as differential, integral, log, and absolute value.

Signal averaging recovers signals buried in random noise and improves measurement accuracy. One or two cursors are selectable for voltage and time measurements. One cursor provides voltage measurements referenced to ground and time measurements referenced to time zero. Two cursors enable Δtime and Δvoltage measurements. Cursors may also be used to bracket an area of interest for measurement.

The 7854's keystroke programming (simply storing a series of keystrokes to be executed) assures repeatable measurement results and lowers the skill level needed to operate the system. Measurement loops save time, log results, and make pass/fail decisions. Full subroutine and conditional branching capabilities are provided.

TekMAP Software Support

The TekMAP (Tektronix Measurement Application Programs) software supports the Tektronix 7000-Series GPIB Programmable Digitizers in automated engineering or research and manufacturing environments.

CHARACTERISTICS

VERTICAL REAL-TIME SYSTEM

Input—Two plug-in compartments; compatible with 7000-Series plug-ins.
Modes—Left, Alt, Add, Chop, Right.
Mainframe Bandwidth—400 MHz with 7A29 or 7A19 Amplifier plug-ins.
Mainframe Step Response—0.9 ns or less with 7A29 or 7A19 Amplifier plug-ins.
Chopped Mode—Chop rate is ≈1 MHz.
Trace Separation Range—In dual-sweep modes, B trace can be positioned 4 div above or below the A trace.

CRT AND DISPLAY FEATURES

CRT Display Modes—Scope (conventional display); Stored (digital data display); Both (stored display plus real-time waveforms); Program Entry (user program text display).

HORIZONTAL REAL-TIME SYSTEM

Input—Two plug-in compartments; compatible with 7000-Series plug-ins.
Modes of Operation—A, Alt, Chop, B.
Fastest Calibrated Sweep Rate—0.5 ns/div.
Chopped Mode—Rep rate is ≈200 kHz.
X-Y Mode—Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02).

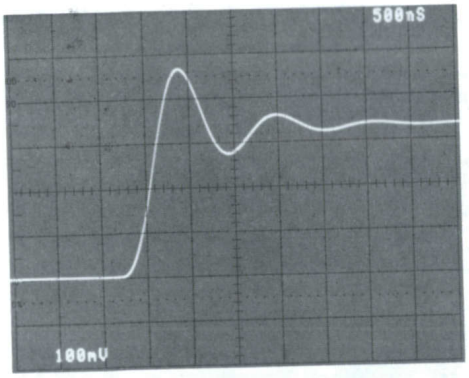
DIGITAL STORAGE

Equivalent-Time Bandwidth—400 MHz. See 7000-Series system bandwidth specifications.
Accuracy—Refer to plug-in specifications.
Acquisition Channels—One or two simultaneous channels (Plug-in Chop mode not valid).
Acquisition Window—±5 div from center screen both vertical and horizontal.
Resolution—Vertical: 0.01 div. Horizontal: Selectable points/waveform on remote keyboard.

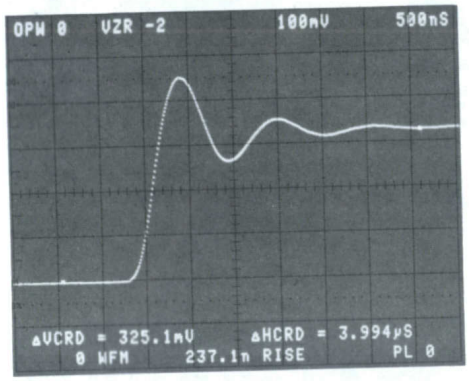
Horizontal Resolution (divs)	Points/Waveform
0.01	1024
0.02	512
0.04	256
0.08	128

PLUG-IN COMPATIBILITY

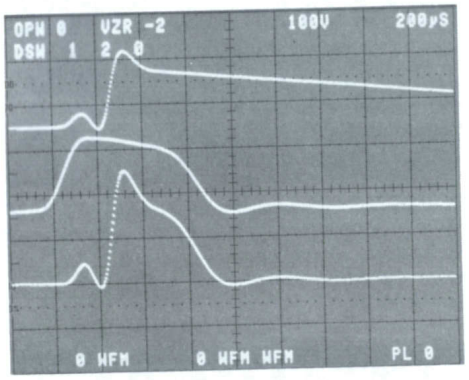
All 7000-Series plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital-storage operation. The 7D01, 7D02, and 7T11 are not compatible in Stored mode.



Conventional Scope: In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high-performance scopes.



Storage Scope: Rise time is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above rise time.

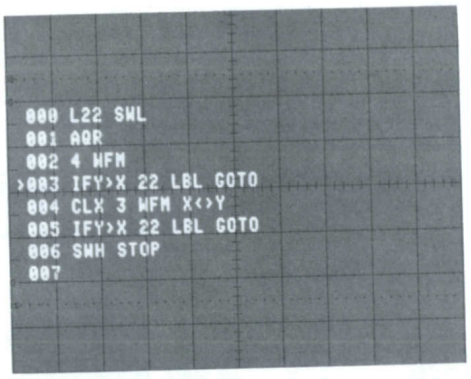


Multiple Storage and Calculation: Volts, current, and power are all shown on the display. Power is a simple two- or three-keystroke calculation.

OUTPUTS/INPUTS

+Sawtooth—Positive going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.

+Gate—Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A gate, B gate, or Delayed gate.



Waveform Processing: Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.

Vertical Signal Out—Selected by A Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.

Remote Single-Sweep Reset—Rear-panel BNC, ground closure activated.

TTL Output—Rear-panel BNC, TTL output under remote-keyboard control (SWH and SWL).

External Z-Axis Input—2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Camera-Power Output—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50-Series cameras.

GPIB Interface Subsets Implemented—SH1, AH1, T5, L3, SR1, RL1, DC1, DT1, PP0, C0.

CALIBRATOR

Voltage Output—Square wave, positive going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

Current Output—40 mA available through Calibrator output with optional BNC-to-current-loop adaptor.

POWER REQUIREMENTS

Line-Voltage Ranges—90 to 132 V. 180 to 250 V.

Line Frequency—48 to 440 Hz.

Maximum Power Consumption—230 W.

PHYSICAL CHARACTERISTICS

	Mainframe		Waveform Calculator	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	305	12.0	277	10.9
Height	348	13.7	69	2.7
Depth	627	24.7	165	6.5
Cord Length ±76 mm			1420	56.0
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	20.4	45.0		
Shipping	28.2	62.0		

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

7854 Oscilloscope, Including Waveform Calculator **$15,275**

Includes: Power cord (161-0066-00); BNC-to-BNC cable (012-0208-00); instruction manual (070-2873-00).

OPTIONS

Option 02—X-Y Phase Correction. **+$260**

Option 03—EMC Modification. **+$395**

Option 78—BE (P11) Phosphor. **+$100**

CONVERSION KIT

4K Expanded Memory—Order 040-0941-00 **$330**

TekMAP SOFTWARE

S42P101 7854 IBM PC Software **$450**

Includes: Software operator manual.

S42H202 7854 HP Series 200 Software **$950**

Includes: Software operator manual.

OPTIONS

Option 01—5¼ inch media. **NC**

Option 02—3½ inch media. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.

Option A2—UK 240 V, 50 Hz.

Option A3—Australian 240 V, 50 Hz.

Option A4—North American 240 V, 60 Hz.

Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins—See 7000-Series Reference section.

Recommended Probes—See Accessories section.

Recommended Camera—See Camera section.

Recommended Cart—The K213 Lab Instrument Cart is recommended for all 7000 Series mainframes. A keyboard tray for the 7854 and a storage area for plug-ins are available as Options 10 and 12, respectively, Option 22 for both. See Accessories section.

Recommended Plotter—HC100 Color Pen Plotter **$775**

SYSTEMS

The 7854 is also available as an MP 2501 Acquisition/Processing Package.

TRAINING

Tektronix offers service training classes on the 7854 Waveform Processing Oscilloscope.

For further training information, contact your local Sales Office and request a copy of the Tektronix Service Training Catalog.

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is in Customer Training section. For further information, or to enroll, call us at 1-800-835-9433, ext. 430. In Oregon, call 1-629-1017 (collect). For international orders, contact your nearest Sales Office.

TekMAP

- **Graphics**
- **Archival Storage**
- **Pulse Parametrics**
- **Delay-Time Measurements**
- **Hard-Copy Dump**
- **Menu Driven**

The TekMAP (Tektronix Measurement Application Programs) library of software products supports the Tektronix 7854 and 7D20 GPIB programmable digitizers in automated engineering or research environments.

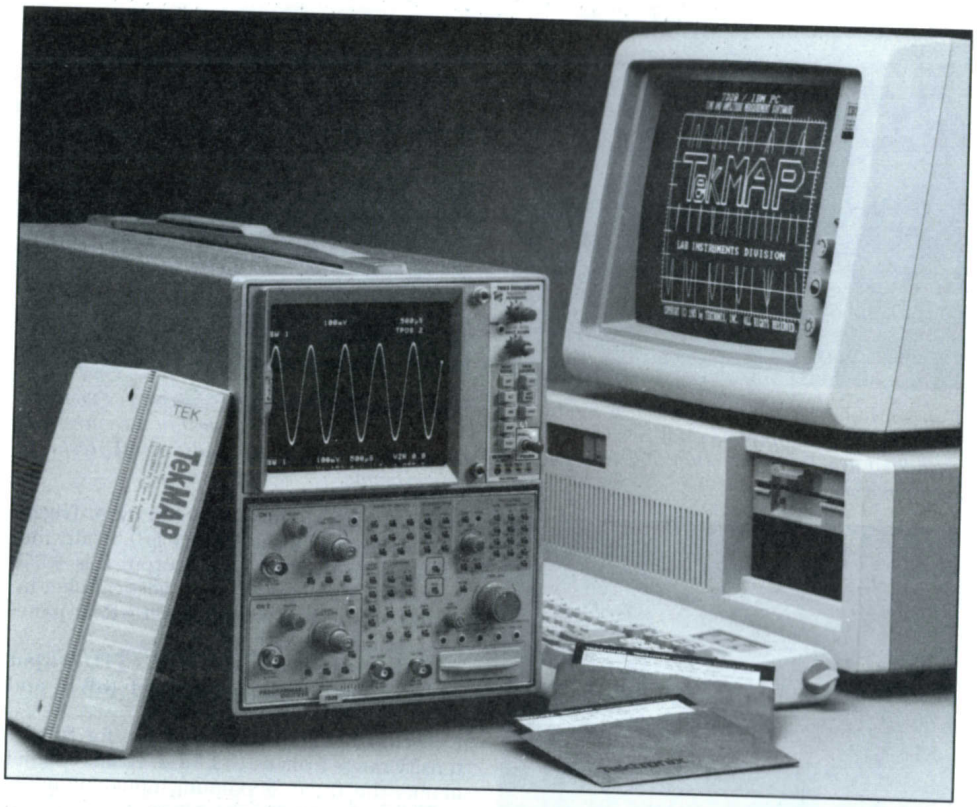
TekMAP software extends the versatility of Tektronix digitizers by integrating them with Tektronix controllers, IBM personal computers, or HP-Series 200 technical computers.

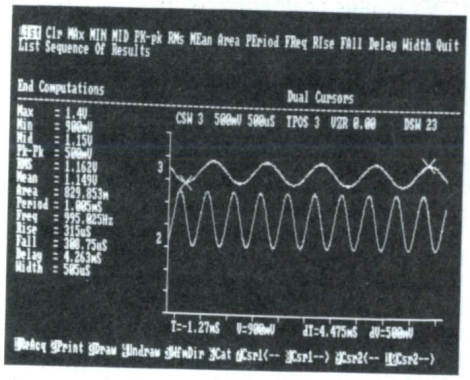
Basic communication utilities, accessible through friendly, menu-driven user interfaces are available through Communication and Control Utility Software.

Extended measurement capabilities, such as automated pulse-parameter analysis, Fast Fourier transformation, and propagation-delay measurements, are provided by the Time and Amplitude Measurement Software products.

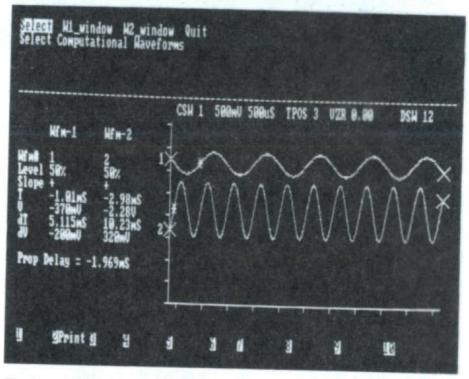
The TekMAP software is a continuing series of applications programs developed and supported by Tektronix applications engineers.

Please contact your local Tektronix Sales Engineer or representative regarding hardware configuration requirements and current software offerings.

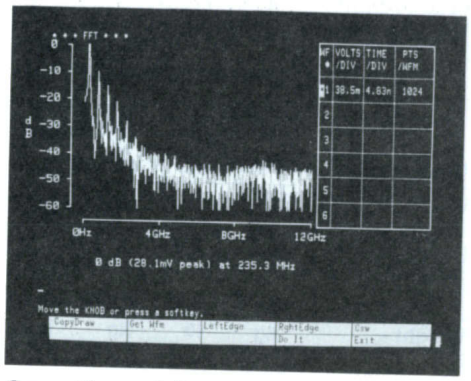




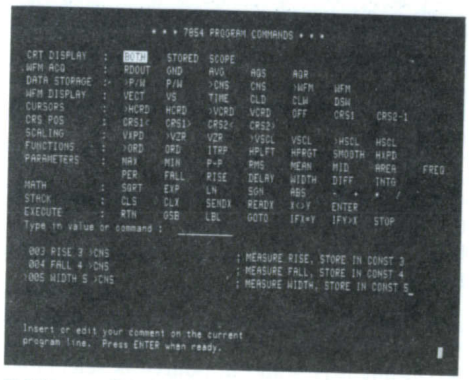
Automatic Pulse-Parameter Analysis using the 7D20/IBM PC Time and Amplitude Measurement Software.



Delay-Time Measurement using an IBM PC/XT/AT as controller with Tek's Time and Amplitude Measurement Software, plus 7D20 Programmable Digitizer and Tek 7603 oscilloscope.



Computing and displaying frequency-domain data using an HP Series 200 Controller and Tek 7854 or 7D20 digitizing oscilloscope.



Editing a Tek 7854 RPN program, including downloading to the 7854 or archiving to disk available in S42H202.

TekMAP SOFTWARE SELECTION GUIDE

	062-7732-00 7D20/Tek 4041 Time and Amplitude Measurement Software	S42P101 7854/IBM PC Communications and Control Software	S42P201 7D20/IBM PC Time and Amplitude Measurement Software	S42H201 7D20/HP Series 200 Time and Amplitude Measurement Software	S42H202 7854/HP Series 200 Time and Amplitude Measurement Software
Required Hardware	Tek 4041 Controller 512K memory R01, R02, R03, R04, ROM Packs Tek 4105A Terminal (or equivalent)	IBM PC, XT, or AT 128K memory Dual floppy or hard drive IBM color graphics board National Instruments PC2, PC-2A GPIB board*1 (Rev C Drivers)	IBM PC, XT, or AT 640K memory Dual floppy or hard drive IBM Color graphics board National Instruments PC2, PC-2A GPIB board*1 (Rev C Drivers) 8087 or 80287 coprocessor	HP 216, 226, 236, or 236C 640K memory 5¼-in. or 3½-in. disk	HP 216, 226, 236, or 236C 640K memory 5¼-in. or 3½-in. disk
Media	DC-100 Tape	5¼-in. DS/DD	5¼-in. DS/DD	5¼-in. or 3½-in. disk (9121, 9122 compatible)	5¼-in. or 3½-in. disk (9121, 9122 compatible)
Operating System	4041 BASIC	DOS 2.0/2.1/3.0/3.1	DOS 2.0/2.1/3.0/3.1	BASIC 3.0	BASIC 3.0
Language	Commented source code 4041 BASIC	Source code for IBM compiled BASIC (for program modification and recompilation)	Executable code only supplied	AUTOST, plus fully commented source code BASIC 3.0	AUTOST, plus fully commented source code BASIC 3.0
Data Acquisition	Remote acquisition (multichannel)	Waveform transfer Manual/Automatic measurement results data logging to disk	Remote acquisition (multichannel) Autoranging for rise, fall, period measurements Acquire from stored settings	Remote acquisition (multichannel) Autoranging for rise, fall, period measurements Acquire from stored settings	Remote acquisition (multichannel)
Measurements	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 100%, 90%, 50% 10%, 0%, Overshoot, Undershoot, Rise, Fall, Width, Period, RMS Selectable measurement region and crossing levels	Provided by 7854	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 100%, Distal, Center, Prox, 0%, +OS, −OS, Rise, Fall, Width, Delay, Period, Freq, RMS List Mode: Mean, Area, Max, Min, Mid, P-P, Rise, Fall, Width, Delay, Period, Freq, RMS Prop Delay Waveform Operations: +, −, *, ÷, Scale, Offset, Diff, Integ, Smooth Cursor (V, T, ΔV, ΔT) Selectable measurement region and crossing levels	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 0%, 100%, RMS, Rise, Fall, Width, Freq, % Overshoot, Period, % Undershoot Prop Delay FFT Cursor (V, T, ΔV, ΔT) Selectable measurement region and crossing levels	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 0%, 100%, RMS, Rise, Fall, Width, Freq, % Overshoot, Period, % Undershoot Prop Delay FFT Cursor (V, T, ΔV, ΔT) Selectable measurement region and crossing levels
Hard Copy	Tek 4695 Color Copier	Graphics dump	Graphics dump	ThinkJet (Text and Graphics)	ThinkJet (Text and Graphics)
Disk Storage	Waveforms (tape storage)	Waveforms; Programs (7854); Logged Data	Waveforms; Settings	Waveforms; Settings	Waveforms; Programs (7854); Logged Data
Utilities	File (Catalog)	File (Catalog, Delete, Drive)	File (Catalog, Delete, Drive)	Copy; File (Catalog, Delete)	Copy; File (Catalog, Delete); 7854 Program Editor

*1 *Available in Tek GURU II package.*

ORDERING INFORMATION

062-7732-00 7D20/Tek 4041 Time and Amplitude Measurement Software, DC-100 Tape **$150**
Includes: Software, operator manual, and license agreement.

S42P101 7854/IBM PC Communication and Control Software **$450**
Includes: Software, operator manual, and license agreement.

S42P201 7D20/IBM PC Time and Amplitude Measurement Software **$450**
Includes: Software, operator manual, and license agreement.

S42H201 7D20/HP Series 200 Time and Amplitude Measurement Software **$950**
Includes: Software, operator manual, and license agreement.

S42H202 7854/HP Series 200 Time and Amplitude Measurement Software **$950**
Includes: Software, operator manual, and license agreement.

OPTIONS

Option 01—5¼-in. flexible disk. **NC**

Option 02—(S42H201/S42H202) 3½-in. single-sided micro disk. **NC**

ASYST Scientific Software

- **Automatic Graphics With Modifiable Defaults**
- **High Resolution and Color-Graphics Support**
- **Comprehensive Data Analysis**
- **Integrated GPIB/IEEE-488 Hardware Support**
- **Built-In Functions Plus Full Programmability**

ASYST is a fully integrated software tool that provides the user with the most commonly used data acquisition, statistical, graphing, and analysis capabilities required in engineering and scientific applications. Operating on the IBM PC/XT/AT, ASYST is designed so novice users can start carrying out complicated operations with a minimum of introduction, while allowing the advanced user to take full advantage of a powerful programming language that supports all of the features of the IBM PC.

Most mathematical or graphics operations can be performed by using a single predefined word describing that operation; e.g., MATRIX.INV, FFT, INTEGRATE.DATA, 2WAY.ANOVA or Y.AUTO.PLOT. New words can be defined to perform any sequence of actions.

```
: PLOT.IT!
PRESSURE
TEMPERATURE
XY.AUTO.PLOT;
```

PLOT.IT! now automatically plots two data arrays when invoked: PRESSURE and TEMPERATURE.

The Analysis module contains most of the common operations used to treat experimental data. These include integration, differentiation, base-line correction, peak finding, digital smoothing, FFT, IFT, matrix manipulation, Eigen system analysis, . . .

Instrument-specific application programs such as the 7000-Series Driver Software for ASYST are also available. Written in the ASYST language, this driver provides the user with a function-key-driven program that allows for the acquisition and storage of waveforms, storage and retrieval of settings or programs, zoned pulse-parametric analysis (max, min, mid, p-p, rise time, fall time, overshoot, undershoot, pulsewidth, period, crossing levels) and frequency-domain analysis. Data may be acquired from the Tek 7D20, 7854, 7912AD, 7912HB, 2230, or 2430A. There is a similar driver for the 11400-Series Digitizing Oscilloscopes.

MODULE 1

SYSTEM/GRAPHICS/STATISTICS

Data Types—Single or double precision, real, integer, or complex values (80-bit double precision); strings; named scalars or arrays. Automatic or user-controlled conversions in mixed expressions between integers, reals, and complex data types. Arrays may have up to 16 dimensions and be as large as 64K bytes apiece.

Arithmetic Operations and Special Functions—+, −, *, /, **, min, max, neg, abs, inv, sqrt, ln, exp, conj, sin, cos, tan, sec, csc, cot, sinh, cosh, tanh, sech, csch, coth, asin, acos, atan, asec, acsc, acot, asinh, acosh, atanh, asech, acsch, acoth. All arithmetic operators work directly (without loops) on all elements of an array. Mixed expressions of arrays and scalars, or arrays of differing dimensionality, are permitted.

Statistical Functions—Mean; variance; mode; median; moments; standard deviation; cumulative distributions; Gaussian, Chi-square, Student-T distributions; random number generation; sort, sort and index.

Array Handling Functions—Subarrays, reversal of indices, transposition of dimension, lesser dimension subsets, individual elements, catenation, lamination, auto entry of array data, scrolling, format control of array data display, generalized inner and outer product, matrix multiplication.

BUILT-IN FULL-SCREEN TEXT EDITOR AND ARRAY EDITOR

Graphics—Automatic line graphs, scatter plots, bar and pie charts, plotting with error bars. Options include: color graphics superposition of plots, multiple graphics windows, polar plots, autoscaling and data fitting, linear or logarithmic display along either axis, strip chart recorder emulation, replotting data subsets with a single keystroke, and support for digital plotters and high-resolution graphics.

Graphics Readout and Cursors—On-screen graphics cursors controlled by arrow keys, labeling at any location within the graphics area.

Control Structures—If. . .else. . .then, Begin. . .until, Begin. . .while. . .repeat, Case. . .of. . .endcase, Do. . .loop; Comparisons: =, <, >, ≤, ≥, not, and, or, xor.

Input/Output—Loading from standard text or arbitrary user-defined files, saving and loading workspace images to disk, direct array I/O to packed-binary disk files, ASCII, BASIC, and DIF format files.

String Handling—String-to-number conversion, number-to-string conversion, string arrays.

GAMMA, BESSEL, AND ERROR FUNCTIONS

RS-232 Support.

MODULE 2

ANALYSIS

Polynomial Mathematics and Evaluation—Polynomial multiplication, synthetic division, integration, differentiation, shifting, root extraction.

Advanced Graphics—Axonometric and contour plots. Plotting with hidden lines removed.

Vectors and Matrices—Matrix inversion, determinants, QR factorization, and Gram-Schmidt orthogonalization.

SOLUTIONS TO SIMULTANEOUS EQUATIONS

Eigenvalues and Eigenvectors—Eigen systems of Hermitian matrices, spectral slicing, reduction of a general matrix to Hessenberg and triangular form.

Curve Fitting—Least squares polynomials, multilinear regressions, parametric and nonlinear curve fitting, weighted least squares, exponential and logarithmic fits, orthogonal polynomials, R^2 (cross-correlation).

NONLINEAR REGRESSION

Advanced Statistics—One- and two-way analysis of variance (ANOVA), F-tests.

Data Manipulation—Data smoothing, differentiation and integration, peak detection, convolutions and filtering.

Fast Fourier Transform, 2D FFT, and Inverse FFT

MODULE 4

GPIB/IEEE-488

Interface Boards Supported—National Instruments GPIB-PC, GPIB-PC2, GPIB-PC2A; IBM Capital Equipment PC-488 model 01000-00300; MetraByte IEEE-488.

Complete IEEE-488 Protocol—Device-dependent and device-independent commands, parallel and serial polling, synchronous and asynchronous operation, DMA acquisition.

Buffering—Array buffering of data. Buffering of device-dependent commands.

Real-Time Synchronization—Triggering, clock-initiated acquisition, software synchronization.

Required Hardware

IBM PC/XT/AT or DOS 2.0/2.1/3.0/3.1 compatible; two or more drives (including one double-sided floppy drive); 512K memory (640K recommended); 8087 or 80287 coprocessor; IBM Color Graphics Board; IBM Enhanced Color Graphics Card (with 64K to 256K graphics memory); or Hercules Graphics Card.

Optional Hardware

IBM graphics printer; Hewlett-Packard 7470, 7475, or Gould Colorwriter plotters, Interface board(s) required for GPIB interface.

ORDERING INFORMATION

S42P301 Option 01 ASYST Scientific Software **$2,095**

Includes: Software (Modules 1, 2, and 4) on 5¼ DS/DD disk, manuals, and license agreement.

S42P302 Option 01 7000-Series Driver Software for ASYST (Requires S42P301 or equivalent software) **$395**

Includes: Software source on 5¼ DS/DD disk, hardware driver for Tek 7D20, 7854, 7912AD, 7912HB, 2230, and 2430A; manual; and license agreement.

S47P303 Option 01 11400-Series Driver for ASYST (Requires S42P301 or equivalent) **$395**

Includes: Software source on 5¼ DS/DD disk, hardware driver for Tek 11401/11402, manual, and license agreement.

11000 -Series Utility Software

GPIB IEEE-488

The 11000-Series complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Archival Storage of Waveforms and Settings**
- **Automated and Manual Logging of Measurement Data**
- **Measurement Data Graphing and Histograms**
- **GPIB and RS-232 Instrument Control**
- **Waveform Acquisition and Display or Template Waveform Creation**
- **Hard-Copy (Printer or Plotter)**
- **BASIC Source Code Included**

The 11000-Series Utility Software packages provide complete GPIB or RS-232 control of the Tektronix 11300-Series programmable oscilloscopes, or the 11400-Series Digitizing oscilloscopes from your IBM PC.

These utility software packages allow you to use the full GPIB or RS-232 programmability of the 11000-Series oscilloscopes without ever having to write a single line of code.

You get the simplest possible access to the measurement system power through each menu-driven package.

All of the major commands and functions are directly executed from the PC's function keys. You choose what you want to do from the 1st-level main menu—acquire measurement data, copy settings, send GPIB interface commands, etc. Then a 2nd-level menu appears, allowing you to select the specific functions or options for the operation or to enter controlling parameters or file names. Required entries from the keyboard are always prompted and are in a simple "fill-in-the-blanks" format.

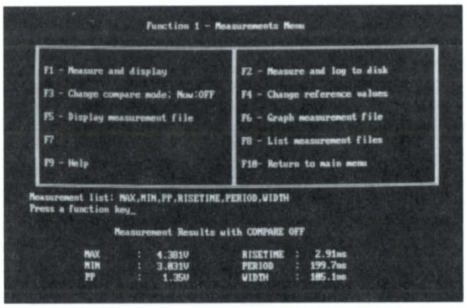
No matter what you select or enter, the Utiliity Software packages do thorough error checking to help ensure the job is done correctly. Also, if there is any ambiguity or error in entries, the packages provide automatic prompting for immediate on-line correction.

If there is ever any question about program operation, simply press F9. This provides complete on-screen help from any menu.

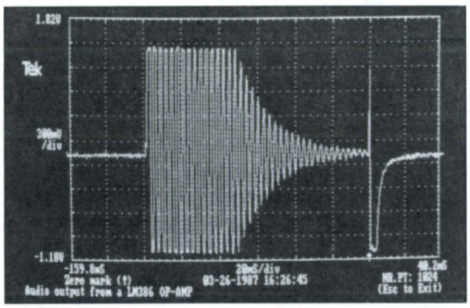
Hardware Configuration

IBM PC, XT, AT or DOS 2.0/2.1/3.0/3.1/3.2 compatible with 640K memory; dual floppy drive or 1 floppy and 1 hard disk; IBM color graphics card (or compatible); National Instruments PC-2 or PC2A GPIB card (for GPIB operation); GPIB cable or a 9-wire RS-232 cable.

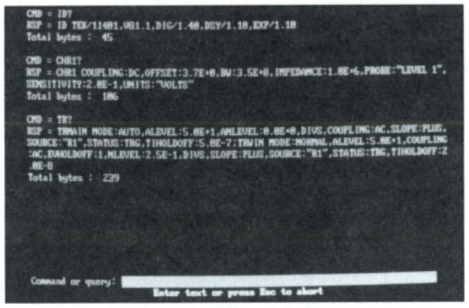
11401/11402 DIGITIZING OSCILLOSCOPE UTILITY SOFTWARE



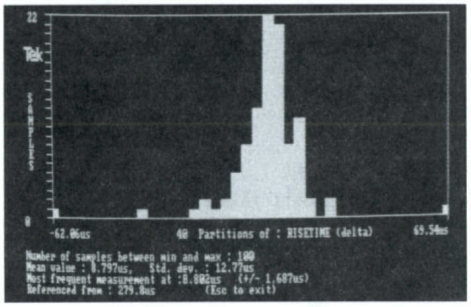
Interaction with the software is simplified through the use of function-key-driven menus as shown above in the Measurement menu.



Waveforms can be acquired and displayed on the PC screen and output to a plotter or dot-matrix printer.

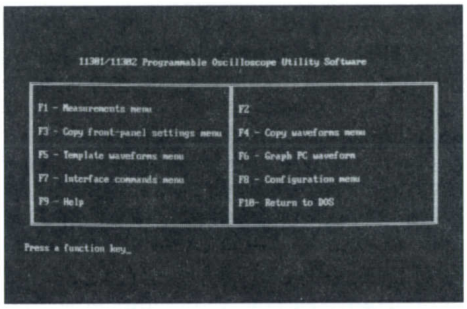


Direct entry of instrument commands is supported with control over GPIB or RS-232 interfaces and screen listing of command responses.

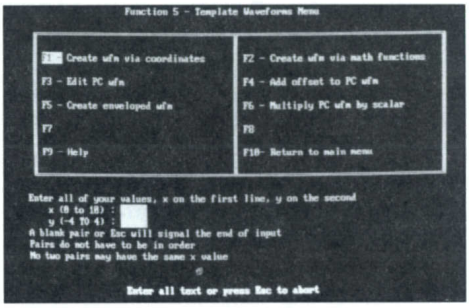


All of the measurement features of the 11400-Series scopes are available through the menus and are supported by measurement logging, statistics, and screen graphics.

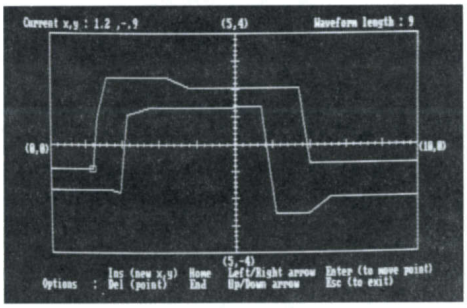
11301/11302 PROGRAMMABLE OSCILLOSCOPE UTILITY SOFTWARE



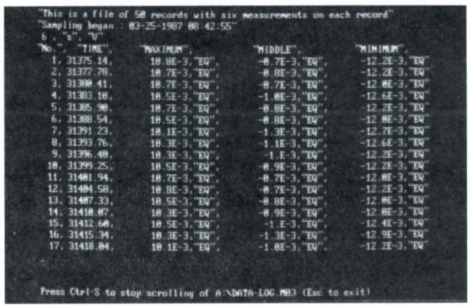
The Main Menu provides submenu access to 7 major operating areas as well as on-screen help.



Template waveforms for limit or comparison testing can be created in the PC and transferred to the 11300 scope.



The use of a graphics editor simplifies the modification of template waveforms.



Measurements acquired with the data-logging function can be listed on-screen or plotted in a graph.

ORDERING INFORMATION

S47P102 Option 1 11401/11402 IBM PC Utility Software **$450**

Includes: Software on 5¼ DS/DD disk, manual, and license agreement.

S47P103 Option 1 11301/11302 IBM PC Utility Software **$450**

Includes: Software on 5¼ DS/DD disk, manual, and license agreement.

SPD

Signal-Processing and Display Programs

- **Support 196 Processing, Analysis, and Data-to-Display Functions on IBM PC, PC/XT, PC/AT**
- **Fast Fourier Transforms (FFT)**
- **Correlation, Convolution, FIR Filters**
- **Extract Pulse Parameters Fast, 13 Functions for Pulse Characterization**

Designed for scientific and engineering users, this package of nine disks, keyboard overlay, and program reference manual includes complete mathematical functions, plus waveform data, I/O utilities, analysis, processing, and graphic display functions. Access is via menu, or C or BASIC for user programmability. Data entry is via disk or GPIB port, using popular waveform digitizers. SPD can directly acquire waveforms from the following Tek digitizers: 2430, 2430A, 2230, 2221, 2220, 7D20, 7912 (AD and HB) 7854, 11400, and RTD 710. Contact your local Tek Sales Office for other digitizers that can be accessed via external software drivers.

Fast Fourier Transforms (FFT)

Based on the Cooley-Tukey algorithm, the FFT is exceptionally useful for extracting frequency components, such as harmonics, from time-domain data.

Six Windowing Functions via TAPER Before Using an FFT

This is a commonly accepted method of reducing frequency leakage in time-domain data caused by sampling a non-integer number of cycles.

Extract Pulse Parameters Fast; 13 Functions for Pulse Characterization

These functions yield useful information on distal, mesial, and proximal point rise and fall times plus overshoot. SPD also reveals more detailed attributes; e.g., period, amplitude, and duty factor.

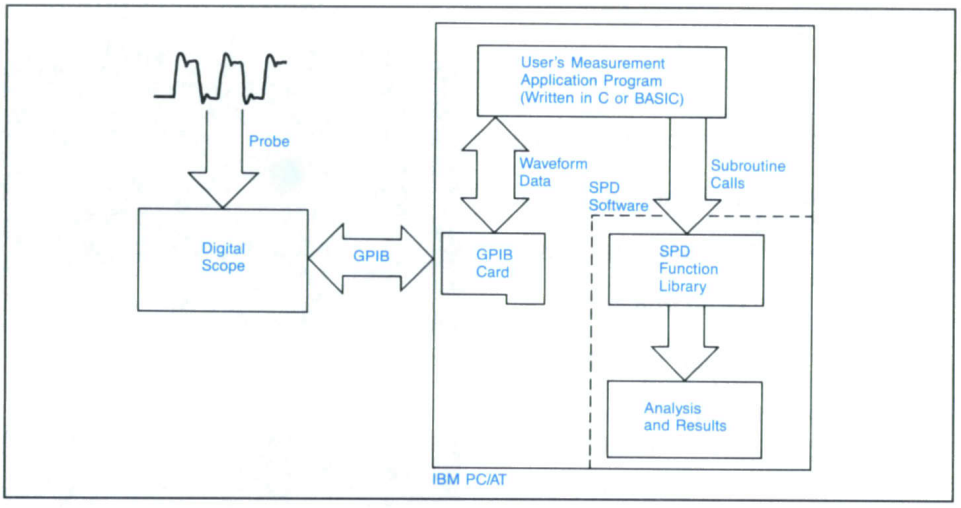
Choose Your Most Productive Access: Friendly Menu For Fast Solutions

You perform sophisticated functions quickly. For example, only three program-prompted keystrokes will window and perform an FFT on time-domain data.

For Productive Programming, Turn to C and BASIC Compilers

SPD is callable from Microsoft QuickBASIC and IBM BASIC Compiler 1.0—ideal for automated data-collection applications requiring extra processing to extract detailed information on correlation, harmonics, pulse parameters, and other specifics. Note: This is the *compiled*, not interpretive, BASIC language.

Users who prefer C programming can readily call SPD functions from this high-level language that is easy to use and compatible with the Microsoft and Lattice C compilers. Contact Tek for more information on compatible compilers.



SPD MAKES DATA ANALYSIS EASY

1. *A probe acquires real-time data from a device under test and sends it to a digital-storage scope like the Tek 2430A.*
2. *The oscilloscope digitizes the waveform and stores it at a 1024×8 bit record, then transfers that record via GPIB to the PC/AT.*
3. *The GPIB IEEE-488 bus transfers data values, scale factors, offsets, and units to and from the PC/AT and the oscilloscope.*
4. *On the IBM PC with GPIB card, SPD processes, analyzes, and displays the record with 196 functions available. SPD may be invoked via menu for ease or C or BASIC for speed and programmability. SPD is aided by optionally available 2430A Driver Utility Software, which acquires the data record.*

At Your Fingertips: Automatically Programmed PC Function Keys

To simplify menu use, each SPD package includes a keyboard overlay with easy-to-follow labeling. The "HELP" key, <1>, provides basic information. <3> always returns you to the main menu.

Device-Independent Graphics

Through the use of device-independent graphics calls and device drivers, SPD supports IBM CGA, EGA, and PGA displays; the new IBM VGA (with appropriate monitor); Hercules monochrome display; all HP plotters; and most IBM plotters and PC printers.

Graphics Without "Jaggies"

A Tek patented anti-aliasing algorithm overcomes the annoying "pixel staircase" look of waveforms.

Store and Describe Multidimensional Data Arrays—With Each Dimension Independent of the Others

You can readily look at data from more directions and in greater detail—down to the single quantity at a single point in a single dimension.

For Fast Program Development, SPD Provides Full Compatibility of C and BASIC

Programming in C: Efficient, easy, and both Microsoft and Lattice compiler compatible.

Programming in BASIC: Ideal for extracting details from automatically collected data; compatible with Microsoft QuickBASIC and IBM BASIC Compiler 1.0. Users can invoke virtually all necessary operations by means of function calls to maximize BASIC programming capability.

Companion products include the Microsoft C Compiler S3FG500, QuickBASIC Compiler S3FG510, compiled BASIC GPIB Interface software S3FG121, and C Compiler GPIB Interface software S3FG122.

ORDERING INFORMATION

S3FG130 Signal Processing and Display (SPD) Programs Software Package **$950**

Includes: Detailed operator manual; IBM function key overlay; and nine disks formatted to be compatible with IBM PC, PC/XT, or PC/AT.

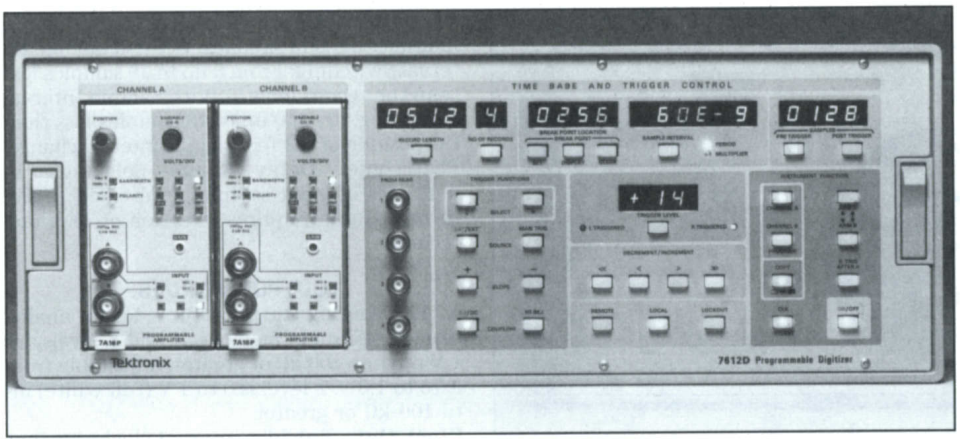
Required Hardware
PEP301 Controller, IBM PC, Portable PC, PC/XT, PC/AT; 256K bytes memory (640K bytes recommended); 1 double-sided, double-density disk drive; 10 Mbyte hard disk drive (highly recommended).

Optional Hardware
8087 or 80287 math coprocessors; IBM printers, plotters.

Graphics Requirements
IBM PC color graphics display and either an IBM Color Graphics Adapter, or IBM Enhanced Graphics Adapter, or IBM Professional Graphics Adapter.

Required Software
IBM PC DOS 2.1 or higher.

Optional Software
Lattice C, IBM BASIC Compiler 1.0.



7612D

GPIB IEEE-488

The 7612D complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats.*

- **200-MHz Maximum Sampling Rate**
- **Two Channels, Two Time Bases**
- **8-Bit Resolution**
- **2048 Words of Memory per Channel**
- **5 ns to 1 s Selectable Sampling Intervals With Interval Switching Allowed During Waveform Acquisition**
- **Pretrigger and Posttrigger Operation**
- **Fully Programmable Over GPIB for System-Oriented Operation**

TYPICAL APPLICATIONS

Automated Testing
LIDAR
EMP
Nondestructive Testing

The 7612D Programmable Digitizer is a dual-channel, dual-time base waveform digitizer for use under computer control. Extracting information from medium-speed signals is a typical application. The 7612D has a maximum sampling rate of 200-MHz. Each channel has its own analog-to-digital converter for accurate, high-speed waveform digitizing, plus its own time base operating from a single 200-MHz crystal-controlled clock. The result. . .two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time-base settings.

There's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digitizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. Waveforms can be viewed before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Channels can be operated dependently by triggering one after the other.

All 7612D functions can be selected manually or operated under program control over the GPIB. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform-acquisition function.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments compatible with all 7000-Series amplifier plug-ins. Fully programmable when 7A16P plug-ins are used.
Bandwidth—80 MHz with 7A16P plug-in.
Modes of Operation—Left channel with Time Base A and right channel with Time Base B.

TIME BASES A AND B

Type—Two built-in digital time bases with a common crystal-controlled clock.
Clock—Internal: 200 MHz ±0.0035%. Stability: Within 10 ppm/year. External: From signal source ≤200 MHz.
Sample Interval—With Internal Clock: Selectable from 5 ns to 1 s in a 1, 2, 3. . .9 sequence (excluding 6, 7, 8 and 9 ns). With External Clock: Selectable from 1 to 200 × 10^6 times the external clock period in a 1, 2, 4, 6. . .20 sequence.
Interval Switching—Sample interval can be changed up to 13 times/waveform record with preservation of time relationships.
Time-Measurement Accuracy—0.0035% (stability 10 ppm/year).
Modes of Operation—Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

TRIGGERING A AND B

Source—Left or right plug-in, external, manual by pushbutton.
Mode—Single sweep.
Coupling—AC, DC, AC HF Rej, DC HF Rej.
Slope—Positive or negative.
Level Range—Internal: At least ±128 LSB in 256 steps. External: At least ±1.28 V in 256 steps.
Trigger Jitter (Internal)—0.1 ns or less, dc to 100 MHz.
Triggering Error—±1 sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).

ARMING A AND B

Pushbutton or computer control.

DIGITIZING AND STORAGE

Method—Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.
Resolution—Eight bits.

Dynamic Accuracy*1

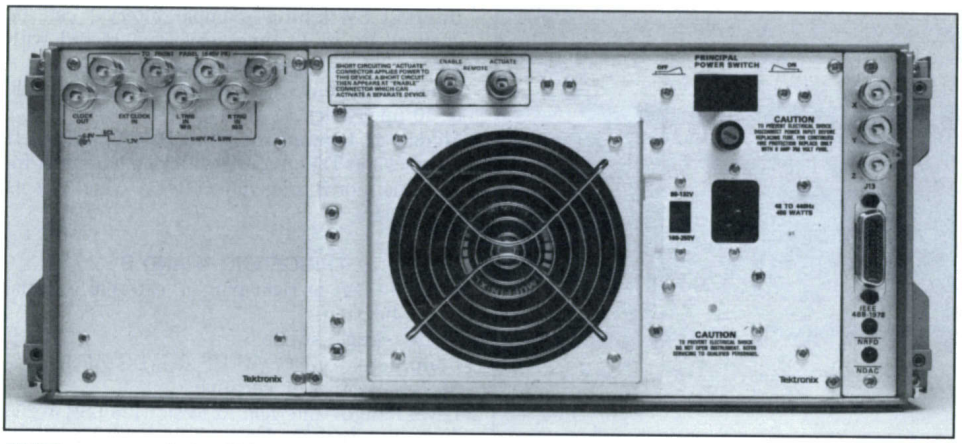
Signal Frequency	S/N Ratio	Effective Bits
300 kHz	42.0 dB	7.8
20 MHz	32.0 dB	6.0
80 MHz	20.0 dB	4.0

*1 *Signal-to-noise ratio performance at 25°C for a half-scale sine-wave input signal (an ideal 8-bit digitizer would give a S/N ratio of 43.8 dB). For further information, refer to HANDSHAKE Vol. 5 No. 1, 33-A-4463.*

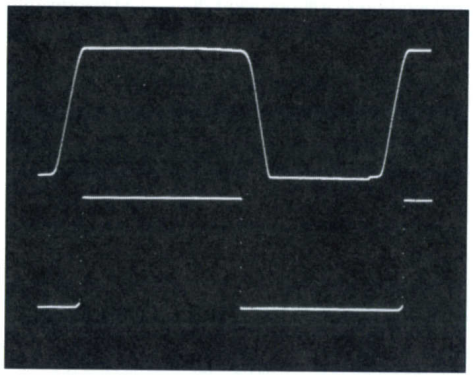
Internal Memory—Type: ECL. Size: 2048 8-bit/channel, total of 4096 8-bit words.
Record Length, A or B—256, 512, 1024, or 2048 samples. Number of Stored Records: Up to eight 256-word, four 512-word, two 1024- word, or one 2048-word records/channel (each requires a trigger). Trigger is automatically re-armed after each record acquisition.

Trigger Sensitivity

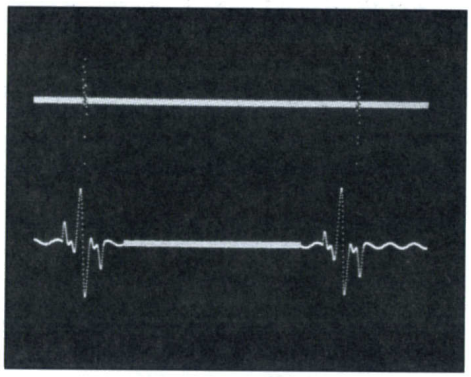
Coupling	Triggering Frequency Range	Minimum Signal Required Internal	Minimum Signal Required External
AC	40 Hz to 50 MHz	20 LSB	100 mV
	50 to 100 MHz	44 LSB	100 mV
AC HF Rej	40 Hz to 50 kHz	20 LSB	100 mV
DC	DC to 50 MHz	20 LSB	100 mV
	50 to 100 MHz	44 LSB	100 mV
DC HF Rej	DC to 50 kHz	20 LSB	100 mV



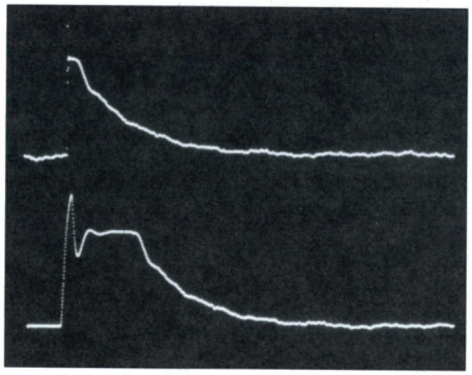
7612D rear panel: the GPIB connector and outputs for an X-Y-Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left); remote power ON/OFF is also provided through the two central BNC connectors.



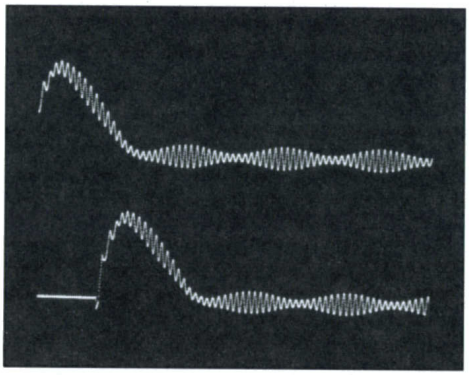
The complete period of a signal (top trace) is recorded at 200 ns. By changing the sample rate to 10 ns during rise and fall times and 800 ns during the plateau (bottom trace), you can measure rise time, fall time, pulse width, and interval accurately on a single-shot signal.



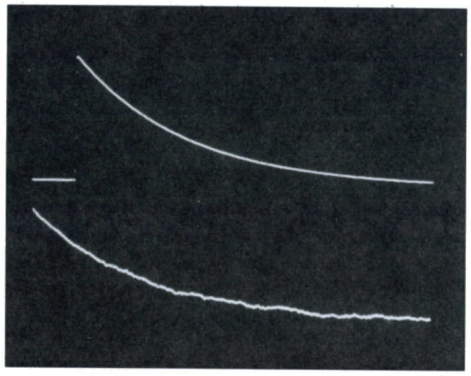
A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.



A decaying signal recorded at a 10-μs sampling rate (top trace); the same signal can be recorded at a 100-ns sampling rate during the initial portion and switched back to a 10-μs sampling rate (bottom trace) to capture all information on a single-shot signal.



The transient response of a system at power-up recorded with no pretrigger (top trace); by using the pretrigger, the complete response can be digitized (bottom trace).



The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after Channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).

Pretrigger Delay Range—Selectable in multiples of eight samples. Without Sample Interval Switching: From 0 up to 16 samples less than the record length. With Sample Interval Switching: From 0 up to 16 samples less than the position of the first sample interval change.
Posttrigger Delay Range—Selectable in multiples of eight samples from eight to the record length (requires selection of only one record).

OUTPUTS/INPUTS

X, Y, Z Analog Output—Provides for analog display of data in memory. X and Y levels are 1 V p-p into 100 kΩ or greater; adjustable from 0.75 to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.
Clock Out—Provides internal clock signal at ECL level.
External Clock—In ECL levels. ≤1 ns rise and fall times. 2.5 ns minimum pulse width and ≤200 MHz.
L and R Trig In—Provide external trigger input to the left and right trigger channels (50 Ω terminated).
1, 2, 3, 4—Four feed-through connections to the front panel.
Digital Interface—Conforms to IEEE Standard 488-1975.

GPIB INTERFACE

Standard Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT0	No device trigger

Response to Interface Control Messages—The 7612D responds to the following interface control messages:

GTL	Go to local
LLO	Local lockout
SDC-DCL	Selected device clear and device clear
SPE-SPD	Serial poll enable and disable
IFC	Interface clear

GPIB Addresses—Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.
Programmable Functions—All instrument settings and operating modes are programmable.
Format—Commands in ASCII, waveform data in binary (range 0 to 377_8).
Transfer Rate—710K bytes/s maximum.
Waveform-Transfer Time—To an Infinitely Fast Controller: 8.35 ms for one 2048-point record. Actual transfer time depends on controller and software speed.

POWER REQUIREMENTS

Line-Voltage Range—90 to 132 V ac, 180 to 250 V ac.
Line Frequency—48 to 440 Hz.
Power Consumption (Including Plug-Ins)—Maximum 400 W, 5 A at 115 V 60 Hz.
Remote Control—Power On/Off capability is provided.

ENVIRONMENTAL

Temperature Range—Operating: 0 to +40°C. Nonoperating: −62 to +85°C.
Altitude—Operating: −76 to +4600 m (−250 to +15,000 ft). Nonoperating: −76 to +15 000 m (−250 to +50,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	483	19.0
Height	178	7.0
Depth	703	27.7
Weight ≈	**kg**	**lb**
Net	25.0	55.0

7A16P

- **Fully Programmable Plug-In for 7912HB or 7612D Digitizers Only**
- **10-mV to 5-V/Div Calibrated Deflection Factors**
- **200-MHz Bandwidth (7900 Family)**
- **50-Ω or 1-MΩ Input Selectable**

The 7A16P is designed for use in Tektronix 7000-Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000-Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB. Whether operated manually or under program control, the front-panel pushbuttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument set-up and control routines.

Two switch-selected input connectors are also provided for selecting input signal source.

CHARACTERISTICS

Bandwidth—Plug-in only: 225 MHz. With the 7912HB: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth-limit switch.
AC Coupled Lower Bandwidth—10 Hz or less.
Step Response—50-Ω input plug-in only, 1.8-ns rise time.
Deflection Factor—10 mV to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated Variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.
Input R and C—Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with VSWR ≤1.5:1 at 200 MHz or less.
Inputs—Selectable A or B signal input connectors.
Maximum Input Voltage—1 MΩ, DC Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, AC Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.
Programmable Functions—All functions except Variable, Gain, and Identify are programmable.

ORDERING INFORMATION

7612D Programmable Digitizer **$29,475**
Includes: GPIB cable (012-0630-03); set of rack slides (351-0375-01); power cord (161-0066-00); operator manual (070-2386-00).

OPTION

Option 06—Reverse airflow **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

7A16P Programmable Amplifier **$2,515**

RECOMMENDED CART

K217 Rack Instrument Cart. See Accessories section. **$510**

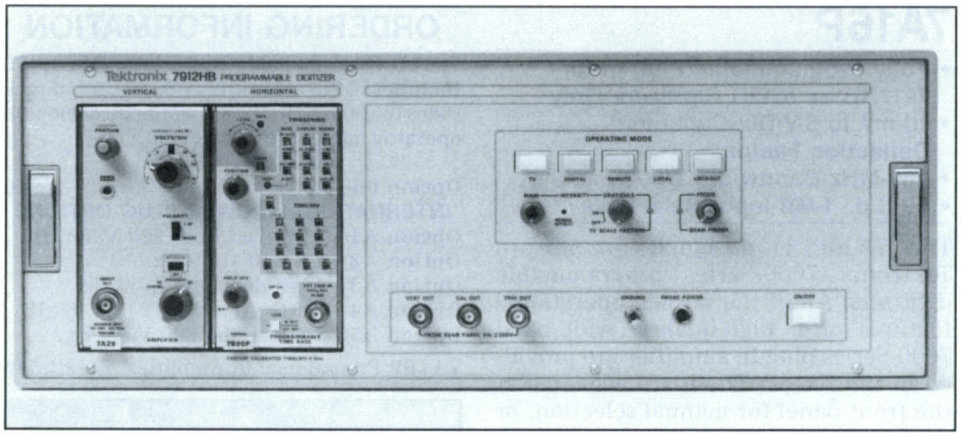
SYSTEMS

The 7612D is also available in MP 1201/MP 2201 Measurement Packages.

TRAINING

Tektronix offers service training classes on the 7612D Programmable Waveform Digitizer. For further training information, contact your local Sales/ Service Office to request a copy of the Customer Service Training Catalog.

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is in the Customer Training section. For further information, or to enroll, call us at 1-800-835-9433, ext. 430. In Oregon, call 1-629-1017 (collect). For international orders, contact your nearest Sales Office.



7912HB shown with the 7A29 and 7B90P plug-ins.

7912HB

GPIB IEEE-488 The 7912HB complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats.*

- **Digitize and Store Single-Shot or Repetitive Signals From Millisecond to Subnanosecond Duration**
- **750-MHz Bandwidth at 10 mV/Div with 7A29P**
- **500-ps/Div Fastest Calibrated Sweep Rate with 7B90P**
- **Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution**
- **Built-In Signal-Averaging Capability**
- **Fully Programmable Over GPIB for System-Oriented Operation**

TYPICAL APPLICATIONS

Destructive Testing
Laser Research
LIDAR
Automated Testing

Capturing high-speed transient signals is the 7912HB's *forte.* Each waveform can be sampled up to 512 times within a selectable time window, ranging from ten milliseconds to five nanoseconds (50-kHz to 100-GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter that writes the signal onto a silicon-diode target array. In TV mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital mode, the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the GPIB to an external controller for processing.

The 7912HB mainframe is also programmable over the GPIB. When the programmable plug-ins (one 7A29P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912HB becomes a fully programmable digitizer with a bandwidth of 750 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Single plug-in compartment accepts any 7000-Series amplifier plug-in. Fully programmable when 7A29P is used.
Bandwidth (Determined by Amplifier Plug-In)—7A16P: 200 MHz. 7A29P: 750 MHz.
Delay Line—Permits viewing leading edge of acquired waveform.

HORIZONTAL SYSTEM

Channels—Single plug-in compartment accepts any 7000-Series time base. Fully programmable with 7B90P.
Fastest Calibrated Sweep Rate—500 ps/div with the 7B90P or 7B92A Time Bases.
Slowest Recommended Sweep Rate—1 ms/div in Digital mode.

DIGITIZING AND STORAGE

Method—Scan conversion.
Resolution—9-bits. In the Digital mode, the target is scanned in a 512×512-point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.
Writing Rate (+10 to +40 °C)—TV Mode: Writes an 8-div sine wave of at least 500 MHz in a single sweep. Digital Mode: Stores a single 8-div pulse with a rise time of 1 ns or less.
Target Defects—No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.
Memory—Type: Semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples/waveform maximum.

ELECTRONIC GRATICULE

8×10-div dot matrix written onto the scan converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

OUTPUTS/INPUTS

X, Y, Z Analog Output—Provides for analog display of data in memory. X and Y levels are 1 V p-p into 100 kΩ or greater; adjustable from 0.75 to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.
Composite Video Output—Available only in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.
Sync Output—At least 4 V into 75 Ω. Conforms to EIA RS-170.
Sync Loop—Allows TV mode to be synchronized with external EIA RS-170 sync waveform.
+Gate Output—Provides a positive pulse with a duration equal to and coincident with the time-base sweep.
Z-Axis Input—±1 V input modulates the writing gun intensity over its full range.
Vert In, Cal In, Trig In—Three internal 50-Ω coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rackmounts.
Probe Power—Provides power for Tektronix active probes.

GPIB INTERFACE

Standard—Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented—SH1, AH1, TE6, LE4, SR1, RL1, PP0, DC1, C0, DT1.

ENVIRONMENTAL

Temperature Range—Operating: 0 to +40 °C. Nonoperating: −55 to +75 °C.
Altitude—Operating: Up to 4600 m (15,000 ft). Nonoperating: Up to 15 000 m (50,000 ft).
EMC (Plug-Ins Inserted)—Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

POWER REQUIREMENTS

Line-Voltage Range—90 to 132 V ac and 180 to 250 V ac.
Line Frequency—48 to 440 Hz.
Power Consumption (Including Plug-Ins)—360 W maximum.
Remote Control—Remote power On/Off capabilities provided.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	483	19.0
Height	178	7.0
Length	679	26.8
Weight ≈	**kg**	**lb**
Net	24.7	54.6

NEW 7A29P

- **Fully Programmable Plug-In for 7912HB or 7912AD Digitizers Only**
- **10-mV to 1-V/Div Calibrated Deflection Factors**
- **750-MHz Bandwidth (with 7912HB)**
- **50-Ω Input Impedance**
- **Input Fully Protected**
- **Normal/Invert Polarity**

The 7A29P is a fully-programmable, high-performance, single-channel amplifier designed for use in Tektronix 7912HB and 7912AD Programmable digitizers. Bandwidth is 750 MHz with the 7912HB, and 500 MHz when used with the 7912AD. The bandwidth is constant over the entire range of deflection sensitivities. Resettable circuitry protects the input against most common overloads. Polarity of the display is selectable.

CHARACTERISTICS

Bandwidth—DC Coupled: 750 MHz (with 7912HB); 500 MHz (with 7912AD).
Deflection Factor—Calibrated: 10 mV to 1 V/div in seven steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated: Variable continuously between steps and a maximum of at least 2.5 V/div (with some bandwidth reduction).
Input Z—50 Ω.
AC Coupling—−3 db at 1 kHz or less from a 50-Ω source.
Maximum Input Voltage—DC Coupled: 25 V or 5 V rms (whichever is less). AC Coupled: 100 V additional (0.25 W sec).
DC Stability—Drift with Ambient Temperature (Line Voltage Constant): 0.04 div/°C or less.
Input Protection—Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 5 V peak. The disconnected condition is indicated and has programmable or manual reset.

7B90P

- **500-ps to 500-ms/Div Calibrated Time Base**
- **Fully Programmable Plug-In 7912HB Digitizer Only**
- **400-MHz Trigger Bandwidth**
- **Single-Sweep Operation**

The programmable 7B90P is designed for use with a Tektronix 7912HB Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the GPIB. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

CHARACTERISTICS

Sweep Rates—500 ms to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.
Sweep Accuracy—Measured over center 8 div, +15 to +35°C, with any 7000-Series programmable mainframe. Derate accuracies by an additional 1% for 0 to +50°C.

Time/Div	Unmagnified	Magnified
500 ms to 100 ns/div	2%	3%
50 to 10 ns/div	3%	4%
500 ps/div	—	5%

Trigger Holdoff—Programmable in 62 steps between minimum and maximum.

Time/Div	Min (ccw)	Max (cw)
500 ps to 2 μs/div	≤3.5 μs	≥90 μs
5 to 20 μs/div	≤35 μs	≥900 μs
50 to 200 μs/div	≤350 μs	≥9 ms
500 μs to 2 ms/div	≤3.5 ms	≥90 ms
5 to 500 ms/div	≤35 ms	≥900 ms

Trigger Sensitivity

P-P AUTO MODE

Triggering Frequency Range	Min Signal Required	
	Int	Ext
At least 50 to 200 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 to 400 MHz	1.5 div	375 mV

NORM MODE

Coupling	Triggering Frequency Range	Min Signal Required	
		Internal	External*1
AC	30 Hz to 50 MHz	0.3 div	100 mV
	50 to 400 MHz	1.5 div	250 mV
AC LF Rej*2	30 kHz to 50 MHz	0.3 div	100 mV
	50 to 400 MHz	1.5 div	250 mV
AC HF Rej*3	30 Hz to 50 kHz	0.3 div	100 mV
DC	DC to 50 MHz	0.3 div	100 mV
	50 to 400 MHz	1.5 div	250 mV

*1 *Ext ÷ 10 operation attenuates ext trigger signal 10 times.*
*2 *Will not trigger on sine waves or <8 div Internal, or 3 V External, at or below 60 Hz.*
*3 *Will not trigger on 50-MHz sine waves 1.5 div or less Internal, or 0.15 V or less External.*

Single-Sweep Mode—Same as Norm mode.
Trigger Level—Programmable in 0.05-div steps.
Horizontal Position—Programmable in 0.0125-div steps unmagnified, 0.125-div steps magnified.
Internal Trigger Jitter—0.1 ns or less at 400 MHz.
External Trigger Input—Selectable: 1 MΩ ±5%, 20 pF ±10% or 50 Ω ±5% with 1.22:1 maximum vswr at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or 1 W for 50 Ω. The level range (excluding p-p Auto) for a 1-kHz sine-wave input is at least ±3 V in Ext and at least ±30 V in Ext ÷ 10.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7912HB*1 Programmable Digitizer **$30,025**
Includes: Power cord (161-0066-00); set of rack slides (351-0375-01); GPIB cables (012-0630-03); operator manual (070-6411-00).

OPTIONS

Option 13—Change TV Scan to 625 lines at 50 Hz. **NC**
Option 30—Delete GPIB Cable. **−$90**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

7A29P Programmable Amplifier **$4,250**
7B90P Programmable Time Base **$2,975**

OPTIONAL ACCESSORIES

Service Manual—Vol.1,
Order 070-6412-00 **$35**
Vol. 2, Order 070-6413-00 **$50**

*1 *It is recommended that 7912HBs not be purchased or operated without an accompanying 634 Raster Scan Display Monitor. Contact your local Sales Engineer for details.*

SYSTEMS

The 7912HB is also available in MP 1101/MP 2101 Measurement Package. See Measurement Packages section.

TRAINING

Tektronix offers service training classes on the 7912HB Programmable Transient Waveform Digitizer. For further training information, contact your local Sales/Service Office to request a copy of the Customer Service Training Catalog.

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is in Customer Training section. For further information, or to enroll, call us at 1-800-835-9433, ext. 430. In Oregon, call collect 1-629-1017. For international orders, contact your nearest Sales Office.

NEW RTD 710

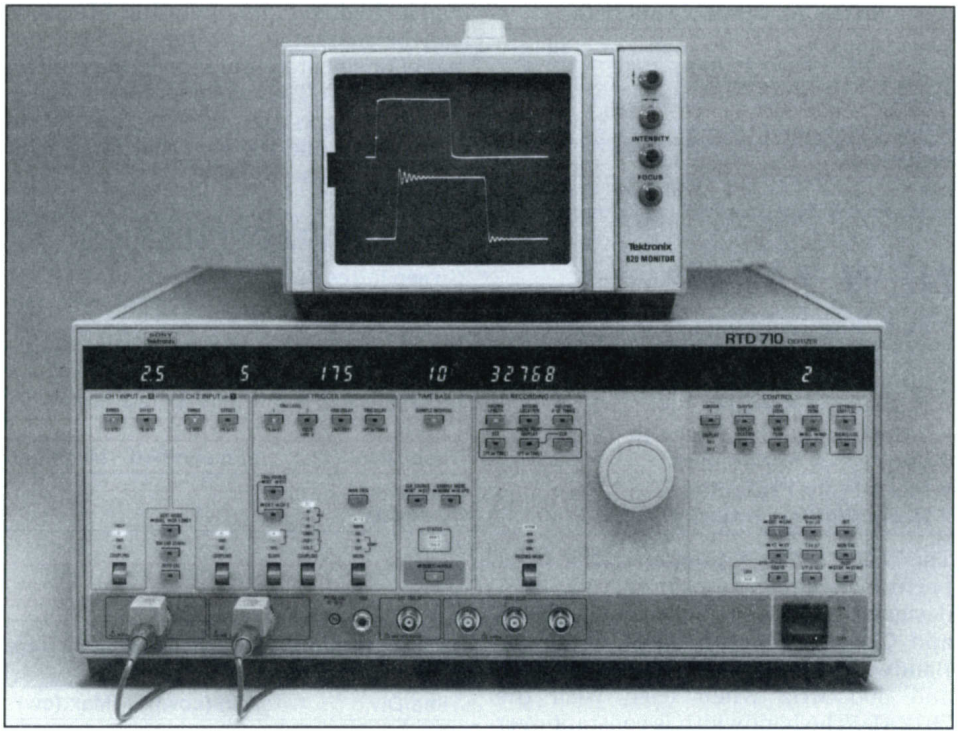
Programmable Waveform Digitizer

GPIB IEEE-488 The RTD 710 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **200 Megasamples/Second (MS/s), Single Channel or**
- **100 Megasamples/Second, Dual Channel**
- **100-MHz Analog Bandwidth**
- **10-bit Vertical Resolution with ±0.4% Gain Accuracy**
- **65536-Word Waveform Memory**
- **Averaging and Envelope Acquisition Operating Modes**
- **Comprehensive Triggering**
- **Cursor Measurements of Time, Voltage, & Frequency**

TYPICAL APPLICATIONS

Semiconductor/Hybrid Test
High-Voltage Testing
Power-Supply Characterization
Pulse-Echo Applications
Ultrasonics
LIDAR/RADAR/SONAR
Video



RTD 710 Programmable Waveform Digitizer

The NEW Sony/Tektronix RTD 710 is a high-resolution transient-waveform digitizer for capturing signals containing frequency components of dc to 100 MHz.

Vertical resolution of 10 bits with gain accuracy to ±0.4% make the RTD 710 ideal for high-resolution applications. In addition, the 200 megasamples per second maximum sampling rate and 100-MHz bandwidth provide the speed necessary for many of today's medium- to high-speed applications.

The RTD 710 also provides flexibility in memory partitioning to suit a variety of acquisition needs. Long record lengths are available with waveform memory of 65536 words for single-channel operation or 32768 words per channel in the dual-channel mode. Record length may range from 1024 to 65536 words. This allows for rapid acquisition of successive single-shot events when used with the Auto Advance Recording mode. Here, multiple events are captured, stored in a predefined memory segment, and the trigger circuit reset to capture the next event.

Sample-rate switching is provided to optimize usage of waveform memory. With sample-rate switching, it is possible to perform fast sampling during periods of interest on the waveform, and then switch to a slower rate during quiescent periods. Up to 5 breakpoints are available per record.

In addition to the normal recording modes, the RTD 710 has a built-in signal-averaging capability. This provides selectable powers-of-two averaging up to 16K to reduce random signal noise.

Envelope mode records minimum and maximum values for each data point over successive acquisitions. This offers a powerful technique for capturing glitch events and for monitoring signal drift. In Comparison triggering mode, the RTD 710 continuously acquires events and compares them to reference-waveform values. If an event deviates from the range of values (Compare Out mode) or lies entirely within them (Compare In mode), the waveform is held for further analysis.

The RTD 710 offers several other advanced triggering modes to simplify the acquisition of complex signals. Hysteresis triggering allows the user to set two threshold levels for added noise immunity. In addition, the RTD 710 has HF Reject, LF Reject, and Bi-slope triggering modes.

The Video Trigger Option is offered to allow the user to trigger on horizontal or vertical video sync pulses. This option makes it possible to trigger on a specific line number within a video field.

When used in conjunction with an optional X-Y-Z monitor, captured waveforms can be viewed and measured in several ways. Cursors offer the capability to measure time, voltage, and frequency. The RTD 710 offers horizontal and vertical display zoom, vertical positioning, and horizontal scrolling for easy viewing of the entire waveform or expansion of smaller portions. Both YT and XY types of displays are available.

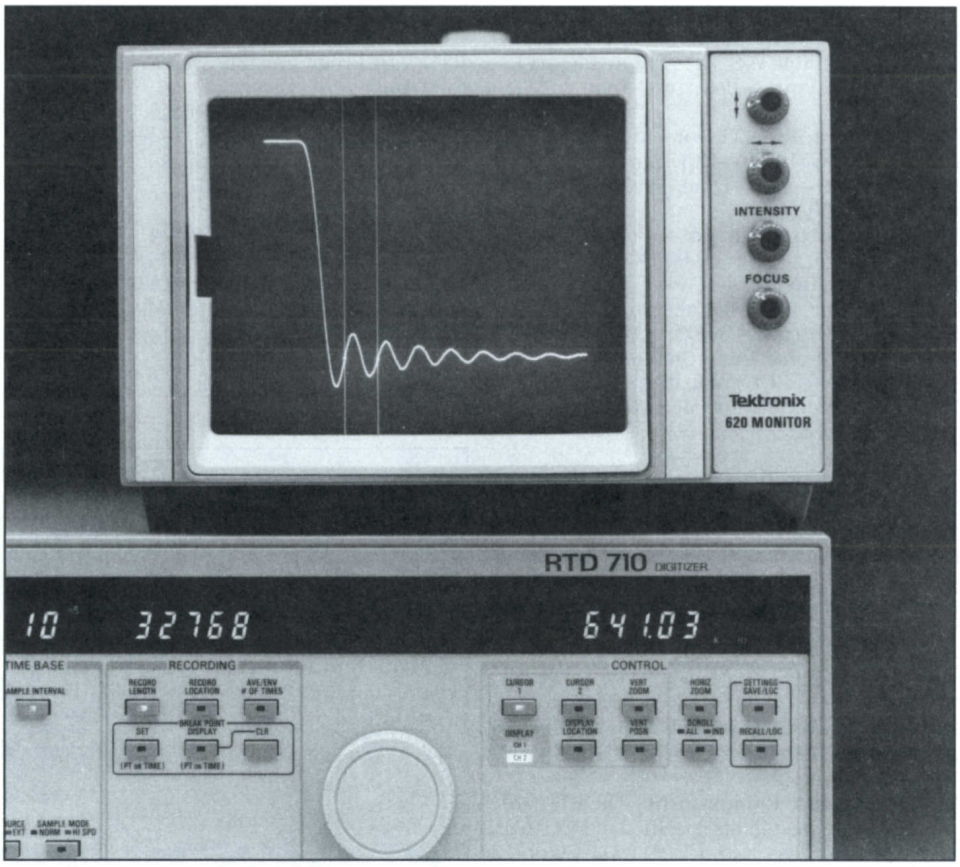
The RTD 710 is fully programmable via the GPIB (IEEE-488) and conforms to Tektronix *Standard Codes and Formats.* It also contains several useful waveform-analysis commands such as min, max, and cross to increase throughput.

Hardcopies of the display can be made with the HC100 Color Plotter via the GPIB. Option 19 provides a blank instrument front panel. This eliminates the RTD 710 front-panel controls, reducing power consumption, instrument cost, and susceptibility to undesired operator adjustment. This is particularly important in test-system environments.

Quicker system set-up time and the convenience of choosing from several previous instrument states is standard on the RTD 710 via non-volatile settings storage. Up to 10 different instrument states can be stored and recalled by either a front-panel pushbutton or under computer control.

Another innovative feature of the RTD 710 is the direct A/D output. By using the direct A/D output, the RTD 710 can be used as a continuous analog-to-digital converter up to 200 MS/s. Record length is limited only by the size of external memory.

Measurement accuracy and proper functioning of the RTD 710 are confirmed by auto-calibration and self-test procedures that are automatically performed at power-on and that the user can activate during operation.



RTD 710 Cursor Display on Tektronix 620 X-Y-Z Monitor.

CHARACTERISTICS

VERTICAL

Input Channels—Two, single ended. Supports X10 and X100 encoded probes for high input voltage applications.
Input Range—±100 mV to ±50 V (200 mV to 100 V p-p) in 28 steps.
Analog Bandwidth—DC to 100 MHz, 0 to 40°C; DC to 90 MHz, 40 to 50°C. Bandwidth limiting at 25 MHz.
AC-Coupled Lower −3-dB Point—10 Hz or less.
Input R and C—1 M ±2%; ≈24 pF.
Maximum Input Voltage—250 V (dc + peak ac); ac component, 500 V p-p maximum at 1 kHz or less.
Input DC Offset Voltage—±199% of input range, selectable in either percent or volts. Accuracy ±1.5% at ±100% dc offset.
Auto Calibration—Gain Accuracy: ±0.4%. DC zero-volt shift ±0.2% (derated with sample-rate switching at 10 and 5 ns.)

TIME-BASE

Internal Clock Frequency—200 MHz ±0.001%.
Sample Rate: Internal Clock—Channel 1 Only Mode, 200 MS/s to 5 S/s, 66 sampling steps; Dual Channel Mode, 100 MS/s to 5 S/s, 65 sampling steps.
External Clock—Channel 1 Only Mode, dc to 200 MHz; Dual Channel Mode, dc to 100 MHz.
Sample-Rate Switching—5 breakpoints maximum per record.

DIGITIZING

Vertical Resolution—10 bits (1024 discrete levels).
Maximum Sample Rates—Single Channel Mode, 200 MS/s; Dual Channel Mode, 100 MS/s.
Record Length—Single Channel Mode, 1 record of 65536 words, or 2 records of 32768 words, or 4 records of 16384 words, or 8 records of 8192 words, or 16 records of 4096 words, or 32 records of 2048 words, or 64 records of 1024 words; Dual Channel Mode, each channel may have 1 record of 32768 words, or 2 records of 16384 words, or 4 records of 8192 words, or 8 records of 4096 words, or 16 records of 2048 words, or 32 records of 1024 words.
Averaging—Selectable from 2 to 16384 in a 2-4-8 binary sequence, 8K maximum record length averaged.
Enveloping—Selectable from 1 to 16384 or infinite in a 2-4-8 binary sequence.

TRIGGERING

Sources—CH 1 internal, CH 2 internal, or external.
Trigger Coupling—AC, AC LF Rej, DC HF Rej, DC.
Slope—Positive, negative, bislope.
Hysteresis—Compare-In, Compare-Out Modes.
Postrigger Delay—From 0 to 65536 sampling points.
Pretrigger Capture—To full record length less 8 for normal mode and full record length less 16 for the high-speed mode.
Arming Delay—Internal: 0, 10 ms to 10 s in a 1-2-5 sequence; External arm input on rear.

DISPLAYS

Cursor Readout—7-digit LED display for time, voltage, and frequency.
Trigger Readout—6-digit LED display for trigger level.
Record Length Readout—5-digit LED display for record length and breakpoint location.
Range/Offset Readout—4-digit LED display for range and offset settings; two displays, one for each channel.

IEEE STANDARD 488 INTERFACE

Standard—IEEE Standard 488-1978.
Interface Functions—SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0.
Maximum Transfer Rate—>250K bytes/second.
Programmable Functions—All instrument settings and operating modes are programmable except the power switch.
Plotter Interface—HPGL protocol, IEEE-488 interface.
Waveform Analysis Routines—Window, Maximum, Minimum, Top, Base, Positive Cross, Negative Cross, Mid, Mean, Peak-to-Peak.

EXTERNAL SIGNALS

CRT Display—X,Y, and Z: ±1 or 5 V p-p, internally selectable (set to +1 V at factory).
Trigger Output—Positive true, TTL-compatible.
External Arm In—TTL-compatible.
External Clock Input—ECL signal level, 50 Ω.
Clock Output—ECL signal level (open emitter out into 50 Ω).
Probe Calibration Output—0 to +4 V ±1% square wave at 1 kHz ±0.005% into 1 M Ω.
Through Connectors—Three 50-Ω coaxial cables for rear signal connections.
Direct A/D Output—50-pin AMPMODU MT connector. Channel 1 and Channel 2 digitized signals available. ECL-compatible signal levels. Maximum data rate is 100 Mega-Words per second (20-bit word).

ENVIRONMENTAL

Temperature Range—Operating 0 to 50°C; Nonoperating −30 to +70°C.
Humidity—0 to 95% relative humidity (noncondensing).
Altitude—Operating 15,000 ft (4.5 km) maximum; Nonoperating 50,000 ft (15 km) maximum.
Line Frequency—Operational from 48 to 440 Hz.
Power Consumption—350 W fully optioned.
Line-Voltage Range—90 to 132 V ac (115 V); 180 to 250 V ac (230 V).
Electromagnetic Compatibility-The RTD 710 qualifies under test limits specified in FCC Part 15, subpart J Class A and VDE 0871 Class B.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	429	16.9
Height	177	7.0
Depth	643	25.3
Weight ≈	**kg**	**lb**
	23.5	51.8

ORDERING INFORMATION

RTD 710 Programmable Waveform Digitizer **$20,950**
Includes: Power cord (161-0123-00), Fuses, 8A & 4A, Instruction Manual (070-6397-00), RTD 710 Instrument Interfacing Guide (070-6423-00).

OPTIONS

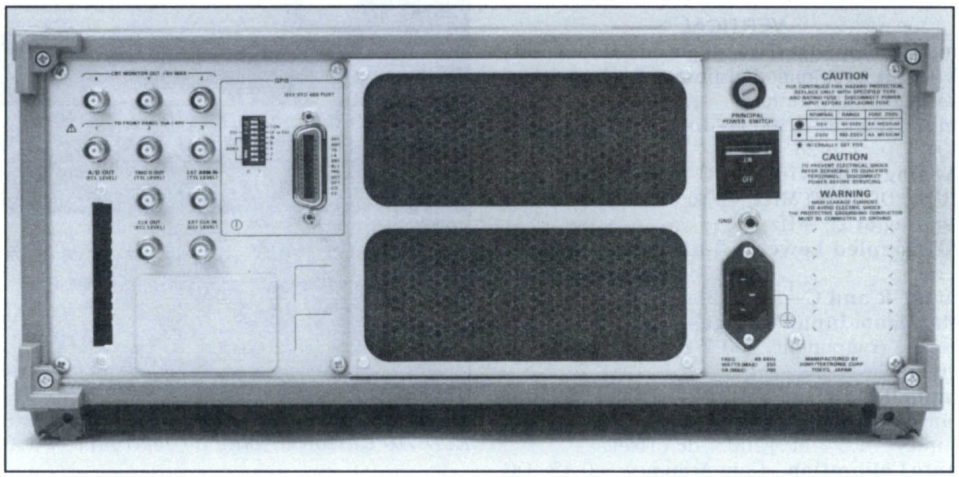
Option 05—Video Trigger **+$1,495**
Option 19—Blank Front Panel **−$500**
Includes: Rack mount assembly.

INTERNATIONAL POWER PLUG OPTIONS

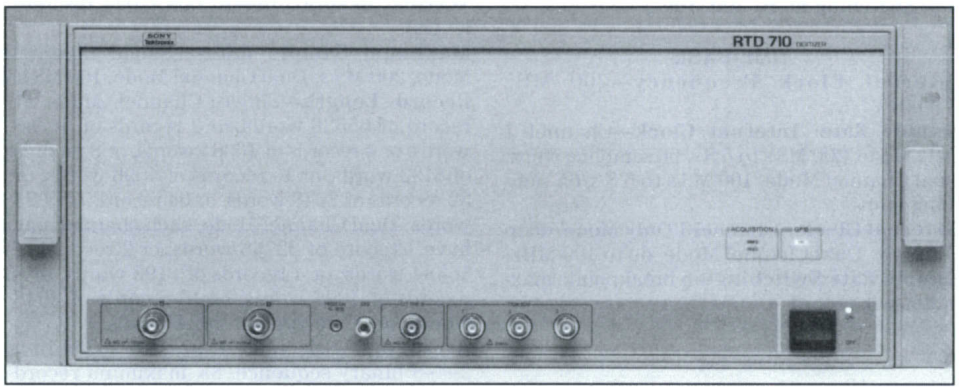
Option A1—Universal Euro 240 V
Option A2—UK 240 V
Option A3—Australian 240 V
Option A4—North American 240 V
Option A5—Swiss 240 V

OPTIONAL ACCESSORIES

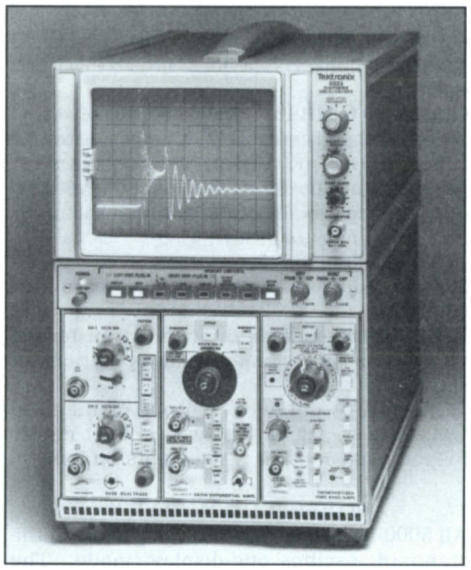
RTD 710—Rack Mount Kit.
Order 016-0886-00 **$670**
RTD 710—Service Manual.
Vol. 1. Order 070-6398-00 **$50**
Vol. 2. Order 070-6399-00 **$50**
GPIB Cable— 2 meters.
Order 012-0991-00 **$155**
A/D Out Cable—2 meters.
Order 012-1117-00 **$70**
HC100 Color Plotter—
Opt. 01—GPIB Cable **$775**



RTD 710 Rear Panel.



RTD 710 Option 19 (blank front panel).



5223

GPIB IEEE-488 The 5223 Option 10 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Digital Storage (With 5B25N)**
- **10-MHz Bandwidth Repetitive Store**
- **100-kHz Bandwidth Single-Shot Store**
- **Pretrigger**
- **10-Bit Vertical Resolution**
- **Stored X Versus Y Display**
- **Roll Mode**
- **X-Y Plotter Output With Pen Lift**

The Tektronix 5223 Digitizing Oscilloscope has a real-time bandwidth of 10 MHz. It is capable of displaying real-time and stored waveforms simultaneously (four real-time waveforms and four stored waveforms, if dual-channel amplifier units are used); the real-time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of ten, using front-panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front-panel display function. The roll mode is useful for viewing low-frequency signals. Rear-panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000-Series plug-in units; the flexibility of the plug-in feature and the variety of plug-in units available allow the system to be used for many measurement applications. The digital-storage functions can only be accessed or enabled by using the 5B25N Time Base.

Display and Save Functions

The Display buttons allow digitization of signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs or until a Save button is pushed. The Save buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

L vs R Display

This function displays the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right defines the horizontal axis.

Since the X-Y display is from memory, the real-time sweep is still in the standard Y-time format and may be displayed simultaneously.

Roll-Mode Display

For continuous data-stream monitoring of biomedical or low-frequency events, the Roll mode digitizes the signal and displays the latest acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip-chart recorder. Roll mode is available on the sweep range of 5 to 0.1 s/div.

Vector Display

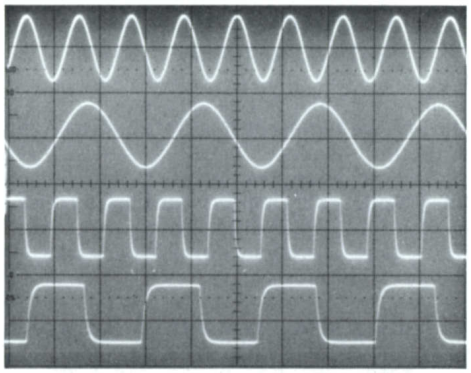
When Vector Display is selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data and reduces interpretation errors.

Output-Saved Displays

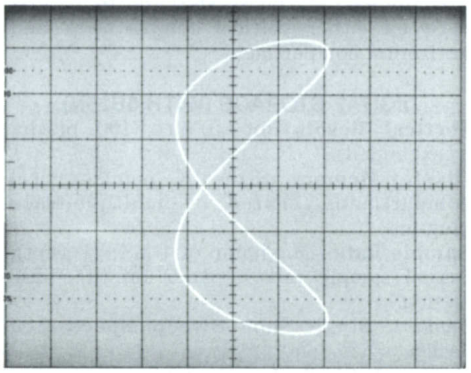
When pressed, an analog output of the displayed/saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

Display-Out Speed Control (Rear Panel)

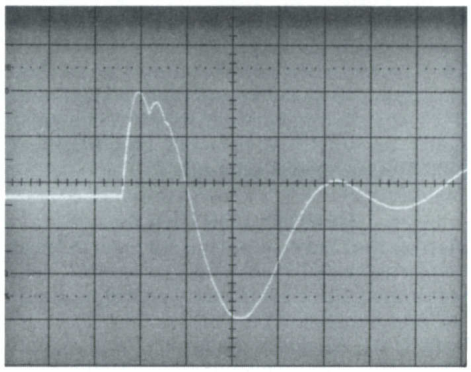
The Display-Out Speed control adjusts the X-Y plotter-output speed to compensate for differences in plotter speeds and response.



Up to four channels may be stored at a time, either Single Shot or Repetitive.



By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.



Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.

CHARACTERISTICS

VERTICAL REAL-TIME SYSTEM

Channels—Two plug-in compartments; compatible with 5000-Series plug ins.
Mainframe Bandwidth—10 MHz with 5A38, or 5A48.
Mainframe Step Response—35 ns.
Chop Mode—100 chopped segments/div unexpanded with 5B25N Time Base.
Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL REAL-TIME SYSTEM

Channel—Single compartment compatible with 5000-Series time bases and amplifiers. 5B25N must be used in storage modes.
Fastest Calibrated Sweep Rate—20 ns/div.
X-Y Mode—<2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

DIGITAL STORAGE (WITH 5B25N)

Vertical Resolution—10-bits (100 pts/div unexpanded).
Display-Memory Size—1K points/vertical compartment, shared by multiple-trace plug-ins.
Sample Rate—Maximum of 1 MS/s (1 μs/pt). Actual sample rate depends on time-base setting.
Fastest Single-Shot Sweep Speed—100 μs/div.
External Clock In—Maximum of 1 MS/s (1 μs/pt). TTL compatible.
Equivalent-Time Bandwidth—10 MHz.
Acquisition Window—±4 div vertically and ±5 div horizontally from center screen.
Accuracy—Determined by plug-ins. Refer to plug-in specifications.
X-Y—(Left vs right single-channel mode only excluding 100-μs/div sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400-Series vertical plug-ins.

MEMORY CONTROLS

Display and Save—Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector mode, Horizontal and Vertical positioning, and expansion (≥10:1).
Data Out—Analog voltage of stored signal. 200 mV/div ±5%. Output rate variable with rear-panel control. Pen lift available on rear panel (normally open).

OUTPUTS/INPUT

Plug-In Signal Outputs—Left, Right Vertical, Horizontal Compartments: 50 mV/div ±5% from 50 Ω. Left, Right Vertical Compartments: DC ≥10 MHz. Horizontal Compartment: DC ≥7 MHz.
Time-Base Gate—TTL compatible, positive going.
Remote Single-Sweep Reset—Rear-panel BNC closure to ground resets sweep.
External Z-Axis Input—Usable, dc ≥5 MHz. Voltage swing of 5 V will fully modulate beam, dc ≥1 MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).
Calibrator Voltage—Output: Square wave, positive going from ground. Amplitude is 300 mV ±1%. Current Output: 3 mA ±1% available through calibrator output with optional BNC-to-current-loop adaptor.

CRT AND DISPLAY FEATURES

CRT—8×10 div with 1.22 cm/div. Internal illuminated graticule.
Phosphor—GH (P31) standard.
Acceleration Potential—15 kV.
Camera Power—Compatible with Tektronix C-59 Camera.

POWER REQUIREMENTS

Line-Voltage Range—90 to 117 V ac, 102 to 132 V ac, 191 to 249 V ac, 204 to 250 V ac maximum.
Line Frequency—48 to 62 Hz (48 to 440 Hz, Option 05).
Maximum Power Consumption—145 W at 120 V, 60 Hz.

OPTIONS

Option 05 Line-Frequency Change (48 to 440 Hz)—Converts the R5223 to 48 to 440 Hz operation.
Option 10 GPIB Interface—For I/O of stored waveforms and control of 5223 digital-storage functions (except vertical and horizontal expansion and position controls). Waveform-output format is selectable through the interface for Binary or ASCII.
I/O Records—Waveforms.
Device Address—Selectable via rear-panel switch.
Talk/Listen—Full bi-direction transfer of waveforms plus remote manipulation of storage controls.
Talk Only—Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

PLUG-IN COMPATIBILITY

All 5000-Series plug-ins are compatible in the standard oscilloscope-display mode. The 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital-storage operation. The 5A14N is not recommended for use in storage mode.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	213	8.4	483	19.0
Height	328	12.9	178	7.0
Depth	572	22.5	569	22.4
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	16.9	37.3	19.1	42.0
Shipping	20.5	45.0	23.6	52.0

5B25N Digital Time Base

- **Bislope Triggering**
- **20-ns to 5-s/Div Calibrated Time Base**
- **Triggering to 15 MHz**

The 5B25N is designed specifically for use in the 5223 Digital-Storage Oscilloscope. Pretrigger is available only with the 5223. However, the standard analog-sweep features, including Bislope Triggering and X10 Mag, are compatible with 5400-Series mainframes.

CHARACTERISTICS

Modes—Auto, Normal, Single Sweep.
Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.
External Trigger Input—Maximum input voltage is 350-V peak. Input R and C is 1 MΩ paralleled by ≈24 pF.
External Horizontal Input—Deflection factor is 50 mV/div ±3%. DC-coupled bandwidth is dc to 2 MHz.
Sweep Rate—0.2 μs to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Triggering

Slope	Frequency Range	Minimum Signal Required Int	Minimum Signal Required Ext
+ or −	DC to 1 MHz	0.4 div	50 mV
	1 to 15 MHz	0.6 div	200 mV
± (Bislope)	DC*1 to 1 MHz	±0.5 div	±50 mV

*1 *30 Hz when ac coupled.*

Bislope Triggering—Will trigger on either a positive or negative slope, and the threshold or sensitivity is controlled by the trigger-level knob. This eliminates the uncertainty of which slope is selected.

CHARACTERISTICS

(WHEN USED WITH THE 5223 MAINFRAME)
Accuracy

Time/Div	Sweep*1	Digitized*2	Digitized to Real Time*3
50 to 0.2 μs/div	3%	3%	3%
1 s/ to 0.1 ms/div	3%	3%	3%
2 and 5 s/div	4%	3%	4%

*1 *Accuracy is specified over the center eight graticule divisions, in 5223 or 5400 Series oscilloscopes. Derate accuracy by 1% for 0 to +50°C, or when using X10 magnifier.*
*2 *Digitized signal accuracy is specified over center eight graticule divisions in 5223 Oscilloscope, excluding first 200 ns or 0.2 div of each waveform.*
*3 *The digitized signal will match the real-time signal within the specified tolerance.*

Pretrigger—For viewing events that occur prior to the trigger and is continuously variable from 0% to 100% of full screen. An intensified zone is generated that corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s to 0.1 ms/div.
Possible Undersampling Indicator—To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.
Sampling Rate—For single-shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.
Repetitive Store—For repetitive signals, the 5B25N controls the equivalent-time sampling feature of the 5223 to allow digitizing from 50 to 0.2 μs/div.
External Clock Input—Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5-V peak input voltage.

ORDERING INFORMATION

5223 Digitizing Oscilloscope **$6,800**
Includes: Power cord (161-0066-00); instruction manual (070-2933-00).
R5223 Rackmount **$7,145**
Includes: Instruction manual (070-2933-00).

OPTIONS

Option 05—Line Freq Change (R5223 only). **+$215**
Option 10—GPIB Interface. **+$810**

CONVERSION KITS

Rackmount-to-Cabinet—Order 040-0975-01 **$330**
Cabinet-to-Rackmount—Order 040-0976-04 **$450**
Adds GPIB Interface to Standard 5223—Order 040-0996-01 **$1,505**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.
5B25N Digital Time Base **$1,230**
Includes: Instruction manual (070-2814-00).

OPTIONAL ACCESSORIES
RECOMMENDED CART

K213—The K213 Lab Instrument Cart is recommended for all 5000-Series oscilloscopes. A storage area for plug-ins is available as Option 12. See Accessories section. **$625**

RECOMMENDED CAMERAS
(See Accessories section.)

C-59A—General purpose. **$1,375**
C-5C—Low Cost. **$495**
C-7—with Auto Eject. **$595**

The Digitizing Camera System consists of C1001 Camera, frame store board inside the PC, DCS software, and cables. The system is shown with Tek PEP301 Controller and HC01 Hard Copy Unit.

DCS01 Digitizing Camera System

- **Adapts to Many Analog Scopes**
- **1-GHz Single Shot With 7104**
- **Works in Tek PEP 301 Controller, IBM PC, or Compatible**
- **12 Bits Nominal Resolution (Repetitive)**
- **Menu-Driven Displays**
- **Waveform Analysis Software**
- **Save on Delta™ Feature**
- **NEW DCS01 Functional Library/Source Code (S58DC01)—Multiple DCS Cards in One PC, Allows Custom DCS Programs**
- **NEW DCS/GPIB Interface for Compatible 2400-Series Scopes—S58DC02**
- **NEW DCS Waveform-Acquisition Modules for SPD™—S58DC03**
- **NEW Utility Set (Free with Registration Return)—Streak-Camera Routine, Dual-Trace Routine, Raw Video Binary Data Converted to ASCII, Multiple Card Routine**

Save on Delta is a trademark of Tektronix, Inc.

TYPICAL APPLICATIONS (DCS01)

High-Energy Physics, Telecommunications, Laser Research, High-Speed Logic, Imaging, Manufacturing QA and QC Waveforms for Manual Production EMP Testing

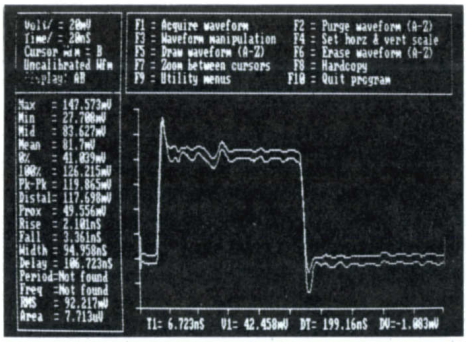
TYPICAL APPLICATIONS (C1001)

Presentations and Training, Remote CRT Monitoring Documentation (with a video copier), Television Work

The Digitizing Camera System (DCS) bridges the gap between the analog scope and PC. On scopes having microchannel-plate (MCP) CRTs, you can capture repetitive and transient signals at the scope's full bandwidth. MCP CRT scopes include the Tektronix 2467, 7104, R7103, and 11302.

Tek merges leading-edge technologies to provide the engineering edge in productivity and reliability.

Blending significant advances in optics, signal-processing hardware and software, with Tektronix' long-standing leadership in CRT technology, the DCS bridges the gap between acquisition tools such as the 11302, 2467, 7104, and other oscilloscopes and processing and analysis tools, such as the PC. For example, you can combine the DCS01 with a Tektronix 7104 real-time oscilloscope to capture events up to 1 GHz. The maximum sampling rate, which depends on sweep speed, is 250 GS/s, or 4 ps/sample. The slower the sweep speed, the lower the sampling rate.

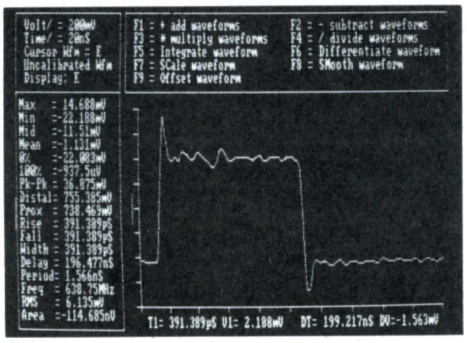


Save-on-delta—Easy-to-use software sequences let you create three types of delta masks. This shows a mask created from two waveforms.

The DCS's charged coupled device (CCD) video camera captures a CRT waveform in digital format, and sends a video signal to the frame/store (a printed circuit board slotted in the PC mainframe). Menu-driven software included with the DCS package lets you easily manipulate the waveform for instant display, signal processing and analysis, hard-copy output, magnetic storage in binary or ASCII converted formats, or porting to a mainframe via RS-232C or GPIB.

DCS Software is fully MS-DOS compatible (2.1 or greater) and is included in the DCS system package.

Easy menu-driven commands provide instant control of many signal-analysis and processing functions. You can display waveforms on the PC together with parametric measurements in another window; zoom in between cursor points for detailed waveform viewing; perform calibration on oscilloscope-camera set-ups—and much more.



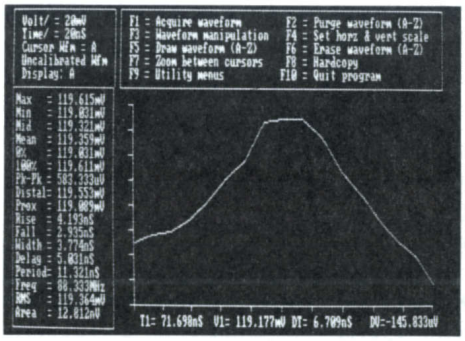
Math operations—Manipulate waveforms mathematically by using such procedures as integration and differentiation, scalar, smoothing, and offsetting (shown on top of the screen).

DCS software makes calibration accurate and simple.
In conjunction with a calibration-signal port on the bottom rear of the DCS camera, you can calibrate both camera and scope from a known signal generated by the frame/store card. Via bar graphs on the PC screen, you adjust for trace intensity, trace width, ground reference, trace rotation, and noise threshold (CCD sensitivity). Under software control, calibration parameters pertaining to voltage and time are established for the measurements you need to make.

Tek C-30 Series camera swing-away bezel adaptors provide compatibility with most analog scopes.
Adjustable magnification allows you to adapt the DCS camera for either 7.2×9.0 cm or 8.0×10.0 cm CRT formats.

A fast f/1.3 lens assures virtually distortion-free imaging.
Specifically designed for the DCS, this spectrally coupled 7-element lens incorporates proprietary optics technology to achieve resolving power of 100 lines/mm at the center and 20 lines/mm at the edge, with a ±0.31% distortion factor. Therefore, imaging without keystoning or other geometric distortion problems is possible.

Optically coupled CCD Video Camera uses 490 by 384 photosensitive elements to capture CRT waveform image.
CCD technology maintains the quality image captured by the lens. There is no image blooming, lagging, "burning," or geometric distortion. Saturation recovery is immediate.



Zoom—By enlarging a designated area between two cursors, you can analyze a waveform segment in greater detail. This is a zoom of part of the waveform shown on the bottom of the previous page.

DCS provides NTSC standard:, RS-170 (video) Camera-to-PC image transmission.
Within the PC, the signal is stored in video RAM on the DCS frame/store circuit board. The frame/store processes the video signal, stores two frames of video information, and reduces selected data to a 512-point waveform array. IBM AT acquisition rate to mass storage is 150–350 ms, depending on the waveform amplitude. Acquisition rate to the PC monitor is approximately 650 ms.

The circuit board also contains hardware for system calibration via internal signal generator, camera power, remote triggering, single-sweep reset, and video-monitor and hard-copy interfaces. The board also supports real-time direct-to-disk writing of event-triggered waveforms (calibrated or uncalibrated), processed waveform data, "raw video," and real-time comparison and summing of video data. The board displays both direct-camera video and previously stored video frames.

DCS software provides a comprehensive:, windowed:, menu-driven toolset that is single-keystroke easy:, yet handles a variety of measurement and analysis tasks.
Complete on one floppy disk, the software is completely compatible with MS-DOS 2.1 or higher. Menu-driven functions get you up and running fast—starting you off with basics like acquisition settings, scope settings, and system focus. You can also invoke commands for graphing and drawing waveforms, as well as windowing parametric functions such as rise time, fall time, frequency, and area under the curve.

Included are tools for implementing the Save-On-Delta™ feature used to set comparative tolerances for capturing and analyzing transient waveforms, plus single sweep and/or auto-log, and self-diagnostics. Signals can be stored on hard or floppy disk. For hardcopies, both Epson and IBM printers are supported in software. Also Tek video copiers can be used to copy PC screens via the CGA card.

Graphics routines for manipulating displayed waveforms include a zoom function for more precise viewing and a text function for affixing on-screen titles to copied waveforms.

Advanced applications libraries support enhanced waveform-acquisition and digitization routines and signal-processing and display functions, including Fast Fourier Transforms. Device driver for waveform analysis includes SPD™. See the Accessories section for more information.

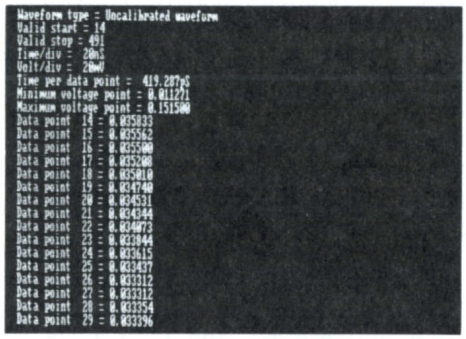
Image Storage
The raw video image stored on the frame/store board can be saved just as the digitized waveform is saved. The 512×512×8 raw video image can be transferred to a floppy or hard disk*1 or it can be saved on video tape for later playback.

The C1001 can be used by itself as a video camera.
This system does not require an IBM PC or the frame/store board, but it does require the use of a power supply. This is available with Option 04 (DX02), which provides camera power and a video output from the camera. The video output can then be fed to a TV screen, video tape machine, or one of the video copiers.

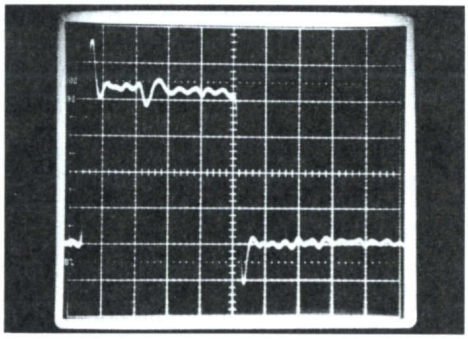
*1 *The 1.2 Mb floppy is recommended for this application since a 360K disk may not have enough space.*

CHARACTERISTICS

See the Camera section for detailed information on the DCS and its optional software.



ASCII files—Select waveform data files and convert them to ASCII data files for printing, reviewing, or transferring to other software programs.



Raw video—Store video frames on video tape or disk for later evaluation. You can also document test set-ups or written materials onto disks. One video image uses about 12K to 250K of a disk.

SYSTEM SUPPORT

CONTENTS

Controllers 392
Software
TEK EZ-TEST 397
GURU II 398
System Support 399

PEP 301 Systems Controller

GPIB IEEE-488

The PEP 301 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **16-MHz Intel 80386 System With the 80387 Coprocessor Standard**
- **1M-Bytes Memory Standard—Expandable to 16M Bytes**
- **1.2M-Byte Floppy and 40M-Byte Hard Disk Standard**
- **Includes GURU II Software for Ease of Configuring With Any IEEE Standard Instrument**
- **14-Inch Color Graphics Display With CGA, EGA, and 800 X 600 Resolution Modes Standard**
- **Detached 101 Advanced Keyboard With Tactile Feedback Keys**
- **MS-DOS and GW-BASIC are Standard**
- **Compatible With PC/XT and PC/AT Software Including Tekware Software From Tektronix for Instrument Control**
- **Clock Speed Controllable to 4.77, 6, 8, or 16 MHz to Permit Maximum Compatibility With Existing User Software**
- **Calendar/Clock Battery Backed**

The PEP 301 Systems Controller brings 32-bit 80386/80387 data-acquisition and processing power to instrument systems control. With processing power 3–4 times a standard 8-MHz 80286-based system, tasks that took too long or were too big to tackle, become reasonable to do with this desk-top controller. Computation is an important part of the task of a controller when used to help analyze the data. The processing power also represents the raw power of the controller to acquire data and convert it to engineering units or to save it on a hard disk for later analysis. The PEP 301 has disk, memory, and processor speeds optimized for demanding applications.

GPIB hardware and software are included to make the controller productive quickly. Commands in the GURU II software (included) provide flexible instrument access through interpreted BASIC.

If applications require faster speed than the interpreter can provide, GURU connects to IBM Compiled BASIC 2.0 and Microsoft QuickBASIC. Supplemental software for GURU provides the link to C compilers from Lattice and Microsoft.

As an MS-DOS compatible instrument controller, the PEP 301 preserves the usefulness of existing instrument-control programs, and of many other programs used in the engineering environment that run on PC/XT, PC/AT, or compatibles.

PEP 301 Hardware

System Unit

The main processor uses a 16-MHz Intel 80386 32-bit processor and 80387 numeric coprocessor. The 80387 supports the instruction set of both the 80287 and 8087, offering additional enhancements that include full compatibility with the IEEE Floating-Point Standard, draft 10. The performance of a 16-MHz 80387 is about eight times faster than a 5-MHz 80287.

The 1M-Byte Random Access Memory, included as standard in the PEP 301, uses interleaving and 100 ns access parts to keep the processor from having to wait for instructions or data—*zero wait states.* Upon initialization, the ROM BIOS is loaded into random-access high memory. By loading a copy of the BIOS into zero-wait-state memory, performance is kept at top operating speed.

Memory includes 256K bytes above the 1M-Byte address space that can be configured to conform to the Lotus/Intel/Microsoft Expanded Memory Standard. Many applications, such as Framework II and Lotus 1–2–3, use Expanded Memory (EMS area) for data.

Hardware clock speed is software selectable to speeds below 16 MHz to provide maximum compatibility with existing software.

To aid set-up, CMOS RAM retains stored settings, and "INSTAL" utilities simplify installing memory management, ram-drivers, and hard disks. Set-up is through simple menu and form-fillout sequences.

Mass storage peripheral space is available for up to two more half-height or one more full-height disk. This means that the system can grow to meet future needs.

Keyboard

The system keyboard is a 101-key "Enhanced AT" style with key click, tactile feel, and separate cursor keys.

Display System

The display controller installed in the systems unit has 256K bytes of video memory providing 16 colors out of a palette of 64. The display card installed in the system unit and the monitor (a multisync display) provide maximum compatibility with Tekware and other software while providing capability to meet demanding color graphics needs.

PEP 301 Software

The PEP 301 controller includes operating system, language, and applications:

MS-DOS 3.2 (later versions when available)
GW-BASIC for running interpreted BASIC programs
GURU II—GPIB Users Resource Utility Software.
MS-DOS 3.2 is upwardly compatible with MS-DOS 3.1 and provides new commands and extensions to existing ones.

In addition to the extensions of MS-DOS, commands added to the controller MS-DOS include:

A system speed command, to set the speed of the processor to 4.77, 6, 8, or 16 MHz clock speed. This allows speed-dependent programs written for a PC/XT, for example, to be executed properly on the PEP 301. In the "Smart" mode, the PEP runs at 16 MHz until floppy-disk access is required. This assures reading floppy disks brought from other PC-compatible products.

A memory manager for installing and using memory above the 1M-byte address limit following the Lotus/Intel/Microsoft Standard.

Diagnostics to provide user trouble shooting and assistance in the event of suspected hardware problems.

An install utility to aid system start-up and maintenance.

GW-BASIC, like BASICA, allows quick interactive programming in interpreted BASIC. In addition to features found in IBM Advanced BASIC, GW-BASIC provides additional screen types including MGA (monochrome graphics adaptor) modes. The screen editor is improved with help modes and improved editing.

GURU II is included to make the PEP 301 Systems Controller productive quickly. Applications, utilities, callable subroutines, and menu-driven operation allow the PEP 301 to be put to work quickly, yet support those applications that require customizing through writing application-specific software. Programs provided are:

Test-procedure generation suited for programmable power supplies, digital voltmeters, signal sources, and counters. Menus mode for selecting pre-written BASIC routines for interrogating and transmitting information on the GPIB, string comparisons, waveform acquisition (in ASCII or binary format), waveform storage and recall from disk, plus 9 other frequently needed functions.

Digitizer support for 2220, 2221, 2230, 2430, 2430A, 7D20, 7912AD, 7854, 11401, 11402, RTD 710, and others is included. Routines simplify capturing data from the oscilloscope or other digitizer, graphing the data, plotting, and analyzing the data. Waveforms can be stored with instrument settings compatible with many popular applications software products such as Lotus 1-2-3, Symphony, and Framework II.

Pulse-Analysis program to simplify characterizing waveform data by rise, fall, and commonly used pulse-measurement parameters.

Sample applications are included that the user can run as is or modify to meet individual needs that do:

Rise- and fall-time pulse measurements with the 2445 and 2465 oscilloscopes.

Scope verification using the CG 5001 programmable oscilloscope calibration generator.

Audio-distortion analysis using the AA 5001 Programmable Distortion Analyzer and SG 5010 Programmable Oscillator.

In addition to Interpretive BASIC programs, GURU includes callable functions that can be accessed from compiled IBM BASIC and QuickBASIC. Most of the sample programs may be compiled after minor editing.

CHARACTERISTICS

SYSTEM UNIT

System board with Intel 80386 processor and 80387 numeric processor. 16-MHz operation, zero wait state, 1M byte RAM on board, 32-bit address, 32-bit data bus, 7 DMA channels, 15 interrupts, 3 programmable timers. System memory is expandable to 16M bytes.

System Panel

Key lock for protecting the system from access when the key is turned to lock position and removed. Two indicators show the speed mode and light when the hard disk is being used. The front panel also has a system reset switch that provides a complete restart of the system without having to turn off power. This reset is positioned to prevent accidental operation, yet convenient to find when needed.

KEYBOARD

The keyboard keys have click and tactile positive feedback. The keyboard is detachable with 10-ft. coil cable. Key layout is the advanced IBM PC/AT 101-key format. LED indicators show Power, Caps Lock, Numeric Lock, and Scroll Lock status. Cursor-arrow keys are separate from numeric keys.

MASS STORAGE

1.2M byte 5.25-in. floppy disk ("A:" drive), half-height, double-sided, double density, 94-ms average access time. The disk is read compatible with 360K-byte drives.

40M-byte Hard-Disk Drive, 5.25 in. with 28-ms average access time.

In addition to the standard disk drives, the controller board can handle one more floppy disk drive and one more hard disk.

DISPLAY SYSTEM

The PEP 301 Systems Controller includes a display monitor and interface card installed in the main system unit. A number of graphics modes are available to support both Tektronix Tekware software and user written or provided applications.

Graphics Modes:
Fully CGA, EGA compatible. Supports standard EGA modes with 640×350, 16-color graphics, and other modes shown below:

Type	Format	Char.Box	Res	Colors
Text/Graphics	40x25	8x16	640x400	16
Text/Graphics	80x25	8x16	640x400	16
Text/Graphics	80x60	8x8	640x480	16
Text/Graphics	80x66	8x8	640x480	16
Text/Graphics	100x75	8x12	752x410	16
Text/Graphics	114x60	8x8	800x600	16

Software drivers are supplied with the PEP 301 to support using the advanced graphics features with applications software users may already own, such as: GEM (version 2.1), Microsoft Windows (version 1.0 or greater), Lotus 1-2-3 (version 2.0 for 132×25 – 44), Framework (version 1.1 or greater), Ventura Publisher (version 1.1 or greater), and AutoCAD (version 2.5 or greater).

Monitor—The display monitor is an Automatic Synchronizing (multi-sync) display.
Scan Rates: Horizontal 15.5 to 37 kHz.
Vertical 45 to 75 Hz
Display Area: 250 by 180 mm
Dot Pitch: 0.31 mm
Video Bandwidth: 30 MHz

INTERFACES

Communications—Two RS-232-C serial ports: One 9-pin "D" male connector, one 25 pin male "D" connector. Programmable baud rate from 50 to 9600 baud.
GPIB—The GPIB port conforms to IEEE Standard 488.
Printer Interface—The printer connector is a Centronics-compatible 25-pin "D" female connector.

POWER REQUIREMENTS

Power Consumption—System Unit: 200 W. Display. Monitor: 85 W.

ENVIRONMENTAL

Temperature—Operating: −10 to +32°C. Nonoperating: −10 to +60°C.
Humidity—Operating: 20 to 80% noncondensing. Nonoperating: 10 to 90% noncondensing.
Altitude—Operating: to 10,000 feet. Nonoperating: to 15,000 feet.

PHYSICAL CHARACTERISTICS

	System Unit		Keyboard		Display Monitor	
Dimensions	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
Width	533	21.0	485	19.1	395	15.6
Height	165	6.5	19.1	0.8	291	11.5
Depth	432	17.0	208	8.2	400	15.8
Weights	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	19.0	41.9	2.7	6.0	14	30.8

ORDERING INFORMATION

PEP 301 Systems Controller **$7,995**
Includes: 1.2M-byte floppy and 40M-byte hard disk, display monitor, and graphics/display card, GPIB interface and cable, 1M-byte RAM, GURU II Software, MS-DOS 3.2 (or later), and GW-BASIC.

OPTIONS

Option 4A—UK keyboard **NC**
Option 4B—French keyboard **NC**
Option 4C—Swedish keyboard **NC**
Option 4G—German keyboard **NC**
Option 4I—Italian keyboard **NC**
Option 4S—Spanish keyboard **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 60 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

4041 System Controller

GPIB IEEE-488

The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

- **Easy-to-Use Extended BASIC**
- **512K bytes Memory Standard**
- **Add-on ROM Enhances the 4041 in the Areas of Graphics and Signal Processing; Other Utilities are Also Available**
- **Easy to Configure With any IEEE Standard 488 Instrument**
- **Execute Only Mode for Program Security on the Production Floor**
- **Detachable Keyboard (Option)**
- **Modular Design—Rackmount or Portable**
- **Flexible and Hard Disk Support With the 4041 Disk Drive Unit**

The one common element that binds both large and small instrumentation systems together is the system controller. The system or instrument controller is in reality just a computer that has been designed to optimize the interaction and communication between the controller and a wide variety of programmable instruments and peripherals. This interaction is enhanced by instrument control commands in a high-level programming language such as BASIC, eliminating the need for the user to understand the IEEE Standard 488 Interface protocol in detail. The user only needs to supply the instrument address and the function to be performed. The controller automatically takes care of the rest—interface handshaking, bus states, and transitions, etc.

The Tektronix 4041 System Controller is a powerful and flexible IEEE Standard 488 (GPIB) Controller, designed to work with Tektronix and other GPIB instruments. The 4041 System Controller standard configuration has an Execute-Only mode that enhances program security in a production environment. Interface, port, and ROM options increase the flexibility of the 4041. The standard 4041 is equipped with a GPIB interface port and an RS-232C serial interface port that is compatible with most terminals, including the full line of Tektronix graphics and alphanumeric terminals. The Extended BASIC Language, also included with the 4041, is easy to use while maintaining the required depth needed for complex programs.

4041 Hardware

The 4041's main processor is the powerful 16-bit 68000 with 512K bytes of standard memory. The versatile front panel of the 4041 is ideal for standalone applications. It includes a 20-character alphanumeric display, 18-key keyboard, DC-100 tape drive, and 20-character thermal printer. On the rear panel is the standard GPIB interface port and an RS-232C serial port.

Several options are available to increase the 4041's capabilities. Option 01 adds another RS-232C serial interface and a second GPIB interface port that can be configured for DMA transfers, allowing fast data transfers across the GPIB bus. Option 03 provides an interface to the 4041 Disk Drive Unit and a second RS-232C interface. The 4041DDU provides additional mass storage, operating efficiency, and flexibility.

Optional ROM expands the existing Basic language by providing commands for creating graphics and processing digitized waveforms—capabilities ideal for signal processing systems. Option 30 is required for program development. Its inclusion as a ROM pack makes it easy for a test engineer or system developer to convert an execute-only 4041 into a development station for debugging, editing, or adding program statements, and then converting back to an execute-only system for operation after the desired program changes have been made.

For extensive program development, the 4041 can be configured so that its RS-232C port is the console. This allows a separate terminal to be used for program development and execution. The 4041 has a complete line editor to allow insertion, deletion, and movement in the line.

The mechanical package of the 4041 is ideal for integration into a system environment. Its small size and ability to be rackmounted allows for easy installation into a system. Combining a 4041 with a TM 5003 and 4041 Disk Drive Unit into a standard 19-inch-wide rackmount package results in a compact system with powerful capabilities.

4041 BASIC

4041 BASIC is a powerful language, optimized for instrument control. It has easy-to-use, high-level GPIB commands in addition to low-level commands required for the most complex applications. English-like syntax and interpreted environment are combined to provide a friendly programming language. To improve self-documentation, the 4041 has the following features:

- Variable names up to eight characters
- FORTRAN-like subprogram calls
- Variable passing from main programs to subprograms
- Local and global variables

Other powerful features include optional data types (integer, short floating point, and long floating point); a Proceed mode that allows I/O and processing operations to run independently for maximum speed; logical unit number and stream specifications to define and characterize I/O-oriented tasks; and 512K bytes of directly addressed memory (without use of expensive overlays or paging techniques).

4041 ROM Packs

Option 10 incorporates the function of the ROM packs (4041R01, 4041R02, 4041R03, and 4041R04) internally, allowing the ROM tray to be used as a ROM program loader.

The 4041R01 Graphics ROM provides high-level commands to easily construct graphic images, symbols, charts, and diagrams into system applications.

The 4041R02 Plotting ROM plots data, draws the axes and tic marks, and draws and scales graphs. Very little programming knowledge is required.

The 4041R03 Signal Processing ROM provides high-level commands for signal processing applications, including the following functions:

- Fast Fourier Transforms (FFT)
- Inverse Fourier Transforms (IFT)
- Integration
- Differentiation
- Correlation
- Convolution

Combine these capabilities with those of the graphics and plotting ROM and processing and displaying complex waveforms becomes easier and faster. Because the commands are in machine language, they run much faster than the equivalent Basic programs.

The 4041R04 adds even more capabilities to the 4041. It is a general-purpose ROM with the following capabilities:

- One-line error messages
- Timers
- Loading Soft ROMs
- Using a ROM as a read-only storage device for fast program loading
- Listing ROM commands

CHARACTERISTICS

FRONT-PANEL KEYBOARD

SYSTEM KEYS

AUTO-LOAD—Causes the internal magnetic tape to rewind and find the "AUTOLD" program. This program is then loaded into memory and execution begins.

ABORT—Halts program execution if no user-specified handler routine is called by the program. If a handler routine is specified for the ABORT key, program control is passed to that routine.

PROCEED—Performs one of the following functions depending on equipment or program state:

1. Causes program execution to start at the next program line if a Pause is encountered.
2. Resumes execution after an ABORT. If a program is loaded from the tape, execution starts from the first program line.
3. Delimits user input when requested from an Input statement.

CLEAR—Clears the alphanumeric display. Does not clear user-defined prompts or the input cursor from an INPUT statement.

EEX—Causes the number requested by an INPUT statement to be entered in scientific notation. Numbers entered after pressing the EEX (Enter Exponent) key are considered part of the exponent.

PAUSE—Halts the program after executing the current line. If the current program line is an INPUT statement, the program stops before the execution of INPUT.

USER-DEFINABLE FUNCTION KEYS

Numeric user-definable function keys, 0-9, can be assigned subroutines by the applications program. The keys can be redefined by the program during execution to allow for unlimited user routines. The function keys can be enabled or disabled under the control of a program.

Numeric values are assigned to these keys for entering information requested by an INPUT statement. When input has been completed, user functions assigned to these keys are re-enabled.

The other two keys on the front-panel keyboard are the decimal key (.) and the minus (−) key. The decimal key is provided for decimal-point entry associated with numeric and the minus key is used to enter negative numbers associated with numeric.

Keyboard overlays can be used for labeling the function keys with a number or an abbreviation of the user routines.

FRONT-PANEL DISPLAY

The front-panel display communicates test procedures and operator prompts, and displays intermediate or final program results. The display is fully programmable.

ALPHANUMERIC DISPLAY

Alphanumeric Line—Twenty characters.
LED—Sixteen segments.
Size—Height: 3.8 mm (0.15 in.). Width: 2.8 mm (0.11 in.).
Character Density—1.6 characters/cm (4 characters/in.).
Character Symbols—64
Message Viewing Time—Programmable.
Scrolling Rate—Programmable.

SYSTEM INDICATORS

LEDs—Located on the display front panel indicate the status of the system.
BUSY—Indicates that a program is running. A blinking BUSY light indicates that the system has PAUSED (temporarily halted).
POWER—Indicates the machine is on.
I/O—Indicates that an Input/Output operation is being performed.
FUNCTION—Indicates that the user-definable function keys are enabled.

MAGNETIC TAPE DRIVE

Magnetic tape drive is used to store user's programs and data. The tape is the primary means of loading programs, particularly for execute-only applications; in addition, the tape drive provides for long-term unattended data logging.

File Structure—48 named files (maximum).
Capacity (Physical Records)—650 typical (600 minimum).
Physical Record—256 bytes (typical tape capacity is 166,400 bytes).
Average Transfer Rate—13,324 bits/s.
Search Speed—1520 mm/s (60 in./s).
Tape Rewind—1520 mm/s (60 in./s).
Tape Cartridge—100A Certified Data Cartridge from Tektronix (equivalent to Scotch DC-100A).

PRINTER

The printer produces hard copies of the intermediate or final program results, operator prompts, and changes in variables or system status. Messages longer than 20 characters are printed on succeeding lines where the user can specify the appropriate indentation for better delineation and readability.

Printing Method—Thermal, fixed head.
Capacity—20-character alphanumeric line.
Font—5×7 dot matrix printhead.
Character Size—2.5 mm high ×1.8 mm wide (0.10 in. high ×0.07 in. wide).
Line Spacing—4.23 mm (6 lines/in.).
Printing Speed—2.0 lines/s.
Feed Speed—8.46 mm/s (0.34 in./s).
Character Set—26 Uppercase letters
26 Lowercase letters
10 Numeric digits
34 Special characters
32 Control characters
128 Total

Paper Size—60 mm×25 m (2.36 in.×82 ft).

CONTROLLING THE BUS

When using BASIC high-level print and input commands, the 4041 automatically controls all bus-management signals in the proper sequence for the desired interface task and instrument interaction. A bus-management function program uses direct IEEE Standard 488 mnemonic commands to accommodate differences in implementation of GPIB on other equipment. Virtually all legal bus states can be programmed this way, which affords a high degree of flexibility for addressing various system applications.

BUS INTERRUPTS

The 4041 has the ability to detect and respond to various types of interrupt conditions that can be generated on the GPIB. User-specified software handlers can be written to perform various tasks when these conditions occur. Interrupts can be enabled or disabled by the program.

Interrupt Conditions

Mnemonic	Message
SRQ	Service Request
EOI	End or Identify
IFC	Interface Clear
DCL	Device Clear
TCT	Take Control
MTA	My Talk Address
MLA	My Listen Address

BUS COMMUNICATION

Interface and bus-device addressing are programmable. This allows the user to direct message and data flow to and/or from the appropriate interface and GPIB peripheral. Information such as primary and secondary addressing, along with pertinent device-dependent information, can be attached to a specific Logical Unit number. Subsequent communication with that GPIB device can be directed to the Logical Unit, eliminating the need for redundant or repetitious statement programming.

TRANSFER RATES (IEEE STANDARD 488)

Transfer Rates for the Standard Interface

	Input	Output
Normal Mode	Exceeds 5K bytes/s	Exceeds 5K bytes/s
Fast Mode	Exceeds 16.5K bytes/s	Exceeds 19.5K bytes/s

SERIAL INTERFACE

The 4041 comes with a standard serial asynchronous RS-232C interface. The 4041 can support applications requiring terminals, modem/host communication, or instrumentation with this interface protocol.

In addition to standard transmission rates from 75 to 9600 baud, transmission rates are programmable to any integer ranging from 2 to 9600 baud.

Full Duplex—Full capability (half duplex not supported).
Transmit/Receive—Matched rate only.
Bits Per Character—5, 6, 7, or 8 bits.
Stop Bits—1 or 2.
Parity—Even, Odd, High, Low, None.

ERRORS AND INTERRUPTS

Conditions such as parity, framing and overrun errors can all be programmably captured. User routines or handlers can then direct what action should be taken, depending on the particular condition.

The end of message delimiter (EOM) can be programmed to any one- or two-character ASCII string. This enables the 4041 to communicate with most hosts or peripherals via the serial interface.

CLOCK/TIMER

One clock provides date and time of day which is programmably set. The timer clock returns the time in seconds since power up. The timer has 10-millisecond resolution.

SELF-TEST

An integral part of the 4041 is the self-test feature, which assures the user of reliable operation. Self-test is executed automatically on power-up and performs extensive hardware and operating system tests.

DYNAMIC RANGE

Short Floating Point—Maximum ±3.40282 E+38; Minimum ±2.93874 E−39.
Long Floating Point—Maximum ±1.7976931348623 E+308; Minimum ± 5.562684646269 E−309.
Integer—−32768 to +32767.
Character String Length (Maximum)—32767.
Array Elements (Real, Integer or Character Arrays)—32767 elements maximum per row (or column); limited by total memory installed.

POWER REQUIREMENTS

Line Voltage—100 to 120 V ac, 200 to 240 V ac ±10%.
Line Frequency—48 to 66 Hz.
Power Consumption—120 W (maximum).

ENVIRONMENTAL

Operating Temperature—Without Data Cartridge or Printer Paper: 0 to +55 °C (+32 to +131 °F). With Data Cartridge or Printer Paper: 0 to +45 °C (+32 to +113 °F).
Storage Temperature—Without Data Cartridge or Printer Paper: −40 to +75 °C (−40 to +167 °F).
Humidity—Relative noncondensing 0 to +45 °C (+32 to +113 °F) −20 to 80% condensing.
Altitude—Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
EMC—Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	213	8.4
Height	178	7.0
Depth	549	21.6
Weight ≈	**kg**	**lb**
Net	7.8	17.3
Net (with options)	8.7	19.3

See ordering information at right.

4041DDU Disk Drive Unit

- **Contains Hard-Disk/Flexible-Disk Drive**
- **10.6M-byte Hard Disk Formatted Capacity**
- **5¼-Inch, High-Capacity Flexible Disk Drive**
- **320K-byte Flexible Disk Formatted Capacity**
- **Interface Directly to 4041 With Option 03**
- **Benchtop, Rackmount or Stack With 4041**

The 4041DDU (Disk Drive Unit) package includes a 10.6M byte hard-disk drive and a 320K byte flexible-disk drive that can be optionally rackmounted. The 4041DDU provides additional mass storage, operating efficiency, and flexibility for the 4041 System Controller equipped with Option 03 disk interface.

The 4041DDU provides local access to high-volume mass storage that adds capacity for a large number of applications programs and a high degree of program flexibility. The high-capacity Winchester hard disk lowers the cost per M byte and provides the level of local data storage and fast access time that interactive graphics, waveform processing, and instrumentation systems require. The maximum number of directory entries defaults to 256 and can be expanded to over 1,000 entries. Sealed drive heads provide improved reliability, environmental protection, and reduced maintenance.

The 4041DDU can be used in conjunction with the 4041's DC100 tape drive, or can operate as the primary mass-storage device for your instrument system controller. The flexible-disk media is the standard 48 tracks per inch, double-sided, double-density diskette. The 4041DDU is enclosed in a cabinet and contains two disk drives, a power supply, controller card, and interface hardware.

CHARACTERISTICS

Capacity—Hard Disk: Formatted 10.6M bytes. Flexible Disk: Formatted 320K bytes including directories.
Recording Format—512 bytes/sector.
Tracks—(Flexible Disk only) 40 tracks per side, double-sided, 48 tracks per inch.
Track Density—Hard Disk: 17 sectors per track. Flexible Disk: 8 sectors per track.
Interfacing—Interfaces directly to the 4041 with Option 03 (disk interface and RS-232C) installed.

POWER REQUIREMENTS

Line Voltage Ranges—90 to 132 V ac at 2 A. 180 to 264 V ac at 1 A.
Line Frequency—47 to 63 Hz.
Maximum Power Consumption—140 W, 510 BTU/hour.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	214	8.4
Height	195	7.7
Depth	540	21.3
Weight ≈	**kg**	**lb**
Net	8.2	20.0

ORDERING INFORMATION

4041 System Controller **$4,950**
Includes: Power cord (161-0066-00); blank overlays for FP keyboard (334-4074-00); system verification tape (062-5828-03); blank DC-100 Tape Cartridge (119-1350-00); RS-232C male loopback connector (013-0198-00); roll of printer paper (006-3557-00); Controller (GPIB) Programming Guide (070-3917-00); operator manual (070-3917-01).

4041DDU Disk Drive Unit **$2,995**
Includes—Power cable (161-0066-00); disk interface cable (012-1117-00); DDU checkout DC100 tape (062-8554-00); 5¼ flexible diskette (119-1870-00); instruction manual.

OPTIONS (4041 only)

Option 01— Second GPIB and RS-232C ports. +$1,200
Option 02—TTL Interface (8-bit Parallel Interface). +$800
Option 03—Disk Interface and RS-232C port. +$1,000
Option 10—Combination of 4041R01 through 4041R04 ROMs. +$1,500
Option 30—Program-Development ROMs and ROM Carrier. +$995
Option 31—Program-Development Keyboard. +$550

CONVERSION KITS

Cabinet-to-Rackmount—(4041) Equipped with slide-out assembly to rackmount a 4041 to the left of a TM 5003. Order 040-0984-02 $215
Cabinet-to-Rackmount—(4041) Equipped with slide-out assembly to rackmount a 4041 to the right of a 7D20T. Order 016-0827-01 $400
Cabinet-to-Rackmount—(4041) Slide-out assembly to rackmount a 4041 with a blank panel. Order 016-0806-00 $410
Cabinet-to-Rackmount—(4041DDU) Slide-out assembly to rackmount a 4041 to the right of a 4041DDU. Order 016-0827-01 $400

4041 ROM PACKS

4041R01—Graphics ROM Pack. $495
4041R02—Plotting ROM Pack. $495
4041R03—Signal Processing ROM Pack. $795
4041R04—Utility ROM Pack. $295
Accessory Package Kit—For use with 4041R04's PROM file system. Order 020-0102-00 $200
EPROM Kit—For 4041R04. Order 020-0101-00 $75

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

4041 FIELD INSTALLED MODIFICATIONS

4041F01—Same as Option 01 $1,400
4041F02—Same as Option 02 $1,000
4041F03—Same as Option 03 $1,200
4041F30—Same as Option 30 $995
4041F31—Same as Option 31 $550
Note: Contact your local Tektronix Sales Engineer before ordering field memory additions.

OPTIONAL ACCESSORIES

Blank ROM Carrier—(4041) Order 013-0215-00 $250
Diskettes—(4041DDU) Package of ten. Order 119-1583-01 $60

TRAINING

Operation and application training workshops applicable to this product are available to the purchaser at 50% off the normal fee, for one seat only for each product purchased. Certain other restrictions apply. Workshop content information is in Customer Training section. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.

TEK EZ-TEST

- **Generate Complex Test Programs Without Programming Skills**
- **Multilevel Menus Guide You Through Test Development Procedures**
- **Color Graphics Plotting of Test and Waveform Data**
- **Translates Generated Procedures into an Easily Modified BASIC Program**

TEK EZ-TEST is a Tektronix 4041 software package designed to help users without computer programming skills quickly and easily produce automated test and measurement programs. The 4041 "learns" the test procedure as it is manually implemented through front panel instrument control. The software queries the instruments involved for their settings, then includes these settings in the program for recall and use during execution. TEK EZ-TEST also checks for instrument command errors as the procedure is being developed, and keeps incorrect settings from being entered.

TEK EZ-TEST software comprises two programs: a GENERATOR and a TRANSLATOR. The GENERATOR produces the test procedures, using programmable test instruments physically attached to the IEEE Standard 488 Bus (GPIB). Once a procedure has been entered into the computer, it can be run and data results obtained. The procedure can be stored on tape (or disk) as a data base and retrieved later for re-execution or modification by the GENERATOR.

All interaction with the system when using the GENERATOR is through menus. This simplifies procedure generation and execution. Software development time and cost are reduced, since there are no complicated codes or key words to learn. Most menus include a HELP key to provide instructions on the use of the various keys and functions.

The TRANSLATOR program is used to convert the GENERATOR-created procedure into an executable 4041 BASIC program. This standalone program will execute faster, is more efficient and more modifiable, and requires less 4041 memory than the procedure from which it was translated.

Translated programs provide the flexibility required by most users who need to implement special functions not provided by the GENERATOR, such as special math functions to operate on acquired data, or acquiring waveforms and operating on them via utilities from the Tektronix Instrumentation Software Library.

Instrument Support

TEK EZ-TEST supports a wide variety of IEEE Standard 488 programmable test-and-measurement instruments from Tektronix. This includes full support for all TM 5000 modular instruments and limited support for: 2400-Series portable scopes; 7D20, 7854, 7612D, 7912AD, and 390AD digitizing scopes; 490P-Series spectrum analyzers; TSI 8150 signal routing and DUT interfacing products; and DAS 9100-Series logic analyzers. Most non-Tektronix, IEEE 488 compatible instruments that use ASCII coded commands and LF/EOI message termination are also supported. When the 4041's Option 01 second GPIB port is installed, up to 28 instruments can be supported.

Required Hardware

4041 System Controller with Version 2.1 Firmware, 512K bytes Memory, Program Development ROMs (Option 30); Tek 4105A (or equivalent) Terminal (RS-232C) or ANSI 3.64 Compatible Terminal.

Optional Hardware

4041 Option 01 (Dual IEEE Standard 488 and RS-232C Ports); 4041 Option 10 (R01, R02, R03, and R04 ROM); 4696 Color Ink-Jet Printer.

ORDERING INFORMATION

TEK EZ-TEST 4205 Terminal Software. Order S45F010 $500
Option 01—floppy disk NC
Option 04—DC-100 tape NC
TEK EZ-TEST ANSI 3.64 Standard Terminal Software. Order S45F020 Option 04 $500

GURU II

- **Store/Recall Waveforms**
- **Calculate Waveform Parameters**
- **Library of Commonly Used Subroutines**
- **Graphics Capability**
- **Flexible Peripheral Handling**
- **Tutorial Manual**
- **Instructional GPIB Programming Examples**

Tektronix GURU II (GPIB User's Resource Utility) is a low-cost hardware/software package for instrument control, waveform acquisition, and display. GURU II supplies the important communication link between an IBM PC (or compatible) and GPIB instrumentation.

The GURU II software is written in IBM's Advanced BASIC (Microsoft's BASICA) language, thus providing maximum flexibility to customize for a specific application. Languages supported include BASICA/GW-BASIC, IBM BASIC Compiler 1.0/2.0, and Microsoft QuickBASIC 1.0/2.0/3.0. GURU II saves data to disk in a format compatible with many popular programs (LOTUS 1-2-3, Framework II, etc.).

The software includes a TEST PROCEDURE GENERATOR (TPG), a useful tool for users who want fast results but do not want to learn to program their own test software. The TPG is a self-explanatory menu-driven program.

GURU II also includes a waveform-acquisition and pulse-analysis program that supports virtually all Tek digitizers. This program allows waveform segmenting, graphics, and storage. The pulse parameters include rise time, fall time, pulse width, max and min voltages, and others.

Library of Commonly Used Subroutines

This library contains subroutines to do low-level communications with GPIB devices, store/recall waveforms on a disk, calculate waveform parameters, and graph the waveform. The subroutines are written in assembly language to facilitate maximum performance when sending or receiving commands or data. Waveform-acquisition performance is further enhanced by the DMA transfer of waveforms to the controller's memory.

Tutorial Manual

The User's Manual is a valuable GPIB reference. It includes many GPIB program examples, which are useful when interfacing to various types of new GPIB instrumentation.

Required Hardware

GURU runs on an IBM PC, PC XT, Portable PC, PC AT, Tektronix PEP 301, or compatible. Minimum requirements: 256K memory and either 2 floppy-disk drives or 1 floppy and 1 hard disk.

GURU also requires one of the following graphics—display card combinations:

1. IBM Color/Graphics Adapter (or compatible card) and the IBM Color Display, Model 5153 (or equivalent), or a composite video monitor (color or monochrome).
2. Hercules Graphics Card and IBM Monochrome Display Model 5151 (or equivalent). For the Hercules Graphics card, the GRAPH X utility from Hercules Computer Technology is required to obtain printer copies of screen graphics. Hercules HBASIC runs GURU graphics programs interpretively, but only on a true IBM PC with IBM DOS/BASICA 2.0 to 3.1.
3. Tektronix PEP 301 display monitor and graphics card.

Optional Hardware

Multifunction card with clock/calendar, serial/parallel ports, and up to 384K bytes of RAM, such as the AST SixPak Plus or the QUADRAM Quadboard.

Additional Hardware Requirements

If the S3FG110 GURU II Software and Documentation only package is ordered (see below), one of the following National Instruments interfaces is needed: GPIB-PC, GPIB-PC2, GPIB-PC2A, or IBM PC GPIB adapter or S3FG120.

Required Software

IBM PC DOS 2.0 to 3.3 or higher with Advanced BASIC (BASICA), or MS-DOS 2.02 to 3.2 or higher with BASICA.

Optional Software

Microsoft QuickBASIC 1.0/2.0/3.0 or IBM BASIC Compiler 1.0/2.0.

Printers Supported

IBM Graphics Printer or equivalent (e.g., Epson RX/FX family, Toshiba P1340/P1350 Series); for Toshiba P1340/P1350, the Paper Screen utility from MAP Systems, Inc. is needed to get printer copies of screen graphics.

ORDERING INFORMATION

S3FG100 GURU II + Package **$850**
Includes: Software/manual plus PC2A board; cable.

S3FG110 GURU II Software and documentation only. **$450**
For users with existing PC2/PC2A board and cable.
Includes: Software and manual.

020-1459-01 Upgrade Kit: GURU II V2.0 to 3.0. **$250**
Includes: Software and manual.

GPIB Interface Hardware

- **Cost-Effective Hardware and Software to Suit Software Developers Who Need Interface Hardware and Software**
- **Example Programs in Interpreted BASICA**
- **Interface Orderable Separately for Compiled BASIC and C Languages**

The GPIB Interface (S3FG120) provides the minimum software and hardware to convert an IBM PC/XT, PC/AT or compatible into an instrument controller. Included are diagnostic utilities, an interactive control program and language interface for BASICA (BASIC interpreter) and manual.

A compiled BASIC interface (S3FG121) includes software for both IBM BASIC Compiler 1.0/2.0 and Microsoft QuickBASIC 1.0/2.0/3.0. The software link provided permits users of the GPIB interface to program their applications in compiled BASIC.

The C compiler interface (S3FG122) links programs compiled in Lattice C (version 2.0/3.0) and Microsoft C compiler (version 3.0/4.0) with the GPIB interface.

ORDERING INFORMATION

S3FG120 GPIB Interface **$495**
Includes: Manual, GPIB interface card, and software on a 5¼" diskette.

S3FG121 GPIB Compiled BASIC Interface **$100**
Includes: Manual, and 5¼" diskette.

S3FG122 GPIB C Compiler Interface **$100**
Includes: Manual, and 5¼" diskette.

TEKTRONIX INSTRUMENTATION SOFTWARE LIBRARY

The Tektronix Instrumentation Software Library provides software and application information to aid in the planning, design, and implementation of measurement solutions using programmable measurement instruments and systems. Currently it contains three types of software—and more are planned.

Measurement Software

Provides solutions to measurement problems using programmable measurement instruments or systems. Measurement Software is user-friendly and ready to run, requiring minimal software integration or modification. Measurement Software is provided only on media.*1

Instrument Utility Software

This is a set of subroutines and subprograms that perform common instrument functions. A single instrument/controller combination is addressed by each subroutine or subprogram. Instrument Utility Software is well documented and presented in a consistent format so it can be easily modified and integrated into application programs that you develop. Instrument Utility Software is provided only on media.*1

User-Exchange Software

Developed by users to perform specific measurements or functions with programmable measurement instruments or systems, User-Exchange Software is available either or media*1 or as listings at no charge.

The Textronix Instrumention Software Library Catalog

Contains abstracts and ordering information for available software. For a copy of the latest catalog, ask your Tektronix Sales Representative for Tektronix Literature 45-W-5570-1.

INTERFACING AND OPERATING SUPPORT

Tektronix provides documentation to help build and use your measurement system. Whether it's interfacing, programming, operation, or maintenance, you'll find what you need in documentation from Tektronix.

Instrument Interfacing Guides

These serve as a system integration guide by aiding in instrument configuration, connection, and operation with a controller. Specific information on the GPIB operation of the instrument along with programming examples are provided. Designed to supplement the operator's manual, they are supplied free of charge with the instrument.

Controller Programming Guides

Supplying an additional aid to GPIB system integration, these programming guides provide specific information and guidelines on a controller's GPIB operating capabilities, as well as suggestions for getting the best performance from your instrument/controller combination. Sample programs are used to demonstrate various aspects of GPIB operation and to show the processing power of the controller.

Operator's and Service Manuals

A standard accessory with each Tektronix instrument and system, these documents provide complete and comprehensive information so you can operate and service your Tektronix measurement system.

PROGRAMMABLE INSTRUMENTS NEWSLETTER

HANDSHAKE

This applications newsletter is for signal processing and programmable instrument control. Published quarterly, it contains technical articles on measurement processes, techniques, and instruments. Subscriptions to *HANDSHAKE* are free upon request from your Tektronix Sales Representative.

ONGOING SUPPORT

Tek's system support doesn't stop when you receive your programmable measurement instrument or system. Our support continues throughout its lifetime through training, application assistance, software support, and service.

Training

To help operators better understand their equipment and get the most out of their systems, training is available both at the home office and at selected sites around the world. In addition, in-depth service training is available for those companies who want to learn to service their own Tek equipment.

Application Assistance

To help solve unique measurement problems our applications assistance is as near as your telephone. If your measurement needs are not answered by our standard software and documentation, Tektronix applications assistance is available in many areas of the U.S. and around the world to help design a solution just to fit your need.

Software Support

To keep your software current and up-to-date, our software support is available at no charge during the warranty period. Post-warranty software support is available on a subscription basis.

Service

For your programmable measurement instrument or system, service is available from Tektronix Service Centers at strategic locations throughout the world. You'll always receive expert assistance from some of the most highly trained and qualified personnel in the world.

For more information on any of the support available for Tektronix programmable measurement instruments or systems, contact your local Tektronix Sales Respresentative for details.

*1 *To order, contact your local Tektronix Sales Office.*

MEASUREMENT PACKAGES

Precise automatic waveform measurements for demanding applications in research, design, manufacturing, and quality assurance

Automatically Saves Time

Tektronix measurement packages are specially designed to handle the increasingly complex, expensive, and time-consuming task of waveform characterization.

They offer all of the power and flexibility of oscilloscope signal acquisition, which can be coupled with programmable stimulus sources for fully automatic analysis. The packages feature signal-processing software with extensive control over instrumentation, waveform manipulations, and graphic display.

Compatibility

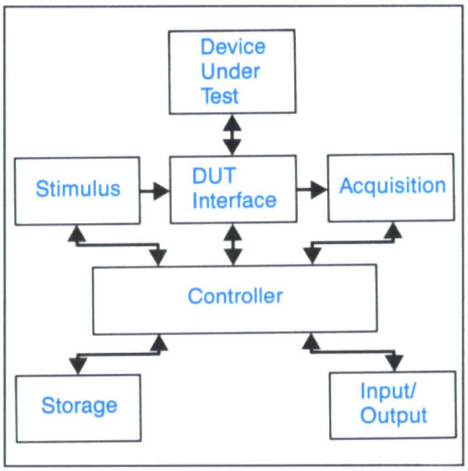
Tektronix measurement packages provide system compatibility to allow configuration for many types of test and measurement applications. This flexibility of specialized instrument selection and easy integration allows the application potential of your automated testing unit to increase with your requirement.

System Building Blocks

Whether your application is in scientific research, engineering design, or automated manufacturing and quality control, Tektronix provides for each of the functions that comprise virtually every measurement system.

Increase Productivity

Tek measurement packages combine state-of-the-art waveform-acquisition capabilities with computer processing and software control. They automatically capture signals, make measurements, then display, store, and document the results. Projects can be completed on time and within budget.



Systems That Put You in Charge

From today's research-and-development tasks to tomorrow's production testing, Tek packages give you all the capabilities needed to characterize your waveforms quickly, efficiently, and accurately.

Device Under Test (DUT)

The system provides stimulus to the DUT and acquires the results from the test.

Stimulus

Stimulus units, including function generators, signal generators, and other sources, provide known control signals to drive the DUT through normal operation patterns or into boundary conditions for performance-limits testing.

DUT Interface

The DUT Interface provides a path from the stimulus and acquisition equipment and the DUT. Tektronix provides a number of GPIB-compatible products for DUT interfacing.

CONTENTS

Custom Test Sytems 217
Measurement Packages
MP 1101 Programmable Digitizer . 401
MP 1201 Programmable Digitizer . 401
MP 2101 Acquisition/Processing . 401
MP 2201 Acquisition/Processing . 401
MP 2501 Acquisition/Processing . 402
MP 2601 Portable 403
NEW MP 1701 Acquisition/ Viewing 404
NEW MP 2701 Acquisition/ Viewing 404
MP 2901 Incoming Inspection Test Station 405
MP 2902 Audio Measurements Package 405

Acquisition

Tektronix provides a wide range of GPIB-compatible test equipment for measuring an acquired signal. The growing family of GPIB-compatible waveform digitizers offers the ability to capture signals ranging from seconds to picoseconds, with bandwidths up to 14 GHz. Plus, compatibility with a broad range of plug-ins provides an added dimension of measurement flexibility.

Processing

Tek measurement systems built around the Tek 4041 feature benchtop convenience with powerful analytical and instrument-control capabilities.

Mass Storage

Mass storage, in disk or magnetic tape form, provides permanent storage and easy retrieval of program and raw or processed data.

INDIVIDUAL PACKAGE CONFIGURATION

Application	Fastest single-shot transient digitizer, highest bandwidth	Multi-record, dual-channel digitizer for single & repetitive signals, high bandwidth	Excellent signal acquisition for repetitive signals, high bandwidth	Extensive signal acquisition capabilities w/ signal analysis	Long record length, dual-channel, versatile digitizer for both single and repetitive signals, high bandwidth	Versatile, compact signal stimulus & acquisition for medium & low speed signals	Makes critical audio measurements consistently, accurately, and quickly
Acquisition Instrument	7912HB	7612D	7854	2430	RTD 710	MI 5010/ MX 5010	SG 50101/ AA 5001
Your own controller	MP 1101	MP 1201		MP 1701			
Compact controller Tektronix 4041 with enhanced instrument control analysis BASIC software	MP 2101	MP 2201	MP 2501	MP 2601	MP 2701	MP 2901	MP 2902

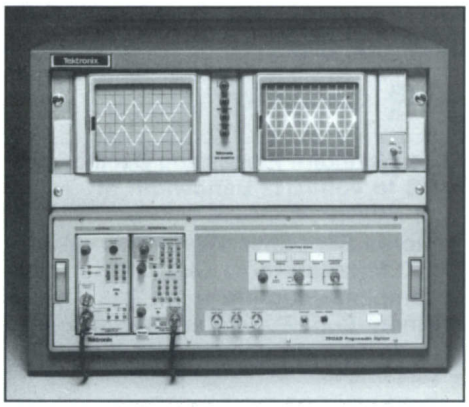
Input/Output Devices

Keyboards and keypads on terminals, controllers, and some instruments provide convenient access to the system.

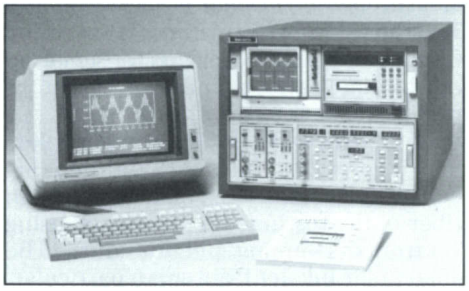
Graphics terminals and hard-copy units provide alphanumeric and graphic presentation of data and programs as well as permanent documentation. Because the quality of the solution is often dependent on the quality of the display, you gain additional advantage by Tek's leadership in high-resolution, reliable graphic and alphanumeric displays.

Software

The Tek 4041 comes with its own version of extended BASIC . . . providing both the simplicity desired by the beginner and the flexibility and power required by the experienced programmer.



MP 1101 (shown above) consists of a 7912HB, 7A29P, 7B90P, 620, and 634. The MP 1201 (not shown) consists of a 7612D, two 7A16Ps, and a 620.



The MP 2201 Measurement Package (shown above) consists of 4205, 4041, special software, plus MP 1201 Measurement Package. The MP 2101 Measurement Package (not shown) replaces the MP 1201 with the MP 1101 and adds special software.

MP 1101/MP 1201

GPIB IEEE-488

The MP 1101 and MP 1201 comply with IEEE Standard 488-1975.

MP 1101 Features:

- **Highest Bandwidth Single-Shot Acquisition (750 MHz at 10 mV/Div)**
- **Fully Programmable up to Maximum Bandwidth**
- **Codes and Formats**

MP 1201 Features:

- **Dual-Channel Signal Acquisition (up to 200 MS/s Sampling Speed)**
- **Signal Bandwidth of 80 MHz**
- **Selectable Record Length From 256 Words to 2048 Words Each Channel**
- **Codes and Formats**

The MP 1101 is based on the high-bandwidth 7912HB Programmable Transient Digitizer. It is excellent for any signal-measurement requirement needing single-shot acquisition (either for computer or operator interpretation of extremely fast signals such as laser research and high-energy physics phenomena). Without a controller, the MP 1101 can be used as a high-bandwidth storage oscilloscope.

Several vertical amplifier plug-ins can be used with the 7912HB. The standard MP 1101 and MP 2101 include the new 7A29P, providing full programmability with 750-MHz analog bandwidth. For cost savings when an appropriate vertical amplifier is already owned, or when the maximum bandwidth is not a requirement, package options allow the 7A29P to be replaced with the 7A19 (600 MHz) or 7A29 (700 MHz) for nonprogrammable operation or with the 7A16P for programmable operation to 200-MHz analog bandwidth, or allow the vertical amplifier to be deleted from the order for credit.

The MP 1201 is based on the 7612D Dual-Channel Programmable Waveform Digitizer. It features very flexible record partitioning during acquisition, allowing up to 13 changes in sampling rate per record for optimum signal resolution and best memory utilization.

CHARACTERISTICS

The following characteristics are the same for the MP 1101 and MP 1201 unless otherwise indicated.

ENVIRONMENTAL

Operating Temperature—0 to +40°C (+32 to +104°F).
Thermal Output—Approximately 1550 BTU/hr.
Operating Altitude—4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage—115 V (nominal).
Line Frequency—60 Hz.
Maximum Power Consumption—450 W (nominal).

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 1101 Programmable Digitizer Measurement Package **$40,700**
Includes: 7912HB; 7A29P; 7B90P; 620; 634 Option 01; mounting hardware; cables; accessories; cabinet.
Option 01—Delete 7A29P and 7B90P Plug-ins. **−$5,490**
Option 1D—Delete cabinet. **−$750**
Option 1S—Substitute 7912AD for 7912HB. **−$1,500**
Option 3D—Delete 7A29P only. **−$2,515**
Option 13—Change TV scan rate to 625 lines at 50 Hz. **NC**

MP 1201 Programmable Digitizer Measurement Package **$37,600**
Includes: 7612D; two 7A16Ps; 620; mounting hardware; cables; accessories.
Option 01—Delete plug-ins. **−$5,030**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

MP 2101/MP2201

GPIB IEEE-488

The MP 2101 and MP 2201 comply with IEEE Standard 488-1975. Both comply with Tektronix *Standard Codes and Formats.*

- **High-Performance Waveform Acquisition**
- **Fully Programmable Over IEEE Standard 488 Bus for System-Oriented Operation**
- **Enhanced BASIC Language—Resident 4041 BASIC With Numerous Extensions**

MP 2101 Features:

- **Ultra High-Speed Single-Shot Digital-Storage Capability**
- **750-MHz Bandwidth at 10 mV/Div and Full Programmability With Standard 7A29P Vertical Plug-In**
- **Codes and Formats**

MP 2201 Features:
- **200 Megasamples per Second Maximum Rate, Each Channel**
- **Two Vertical Channels, Two Independent Time Bases**
- **Eight-Bit Resolution**
- **Codes and Formats Features**

The MP 2101 provides the highest bandwidth for single-shot applications, as well as built-in signal averaging. The MP 2201 provides true dual-channel, 200-MS/s digitizing with up to 80-MHz analog bandwidth, and can be tailored for different signal characteristics using 7000-Series plug-ins. The optional 4696 Color Ink-Jet Printer extends the usefulness of these packages.

The special MP software included with these packages enables the operator to acquire, analyze (min/max, histogram), process (correlate, convolve, FFT, etc.), display, and store waveforms from the system terminal via easy-to-use menus. The software is also designed to accommodate multiple digitizers of the same type in each system (up to 28 digitizers per system with optional second IEEE-488 bus).

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature—+10 to +35 °C (+50 to +95 °F).
Thermal Output—Approximately 3750 BTU/hr.
Operating Altitude—4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage—115 V (nominal).
Line Frequency—60 Hz.
Maximum Power Consumption—1100 W.

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2101 Acquisition/Processing Measurement Package **$51,200**
Includes: MP 1101; 4041, 4205, cabinet, software.
MP 2201 Acquisition/Processing Measurement Package **$48,200**
Includes: MP 1201; 4041, 4205, cabinet, software.

OPTIONS

Option 01—(MP 2101) Delete 7A29P and 7B90P plug-ins **−$5,490**
Option 01—(MP 2201) Delete (2) 7A16P plug-ins. **−$5,030**
Option 1D—(MP 2101) Delete cabinet. **−$750**
Option 1S—(MP 2101) substitute 7912AD for 7912HB. **−$1,500**
Option 3D—(MP 2101) Delete 7A29P only. **−$2,515**
Option 13—(MP 2101) Change TV scan rate to 625 lines at 50 Hz. **NC**
Option 18—Add Tektronix 4696 Color Ink-Jet Printer. See Information Display Products section. **+$1,795**
Option 22—Adds Option 01 to 4041 (second GPIB interface and second RS-232C port). This option is not available with Option 23. **+$1,200**
Option 23—Add Option 03 to 4041 (disk interface and second RS-232C port). This option is not available with Option 22. **+$1,000**
Option 26—Adds 4041DDU (10 Mb hard disk and 5¼ in. flexible disk). Requires Option 23. **+$1,995**

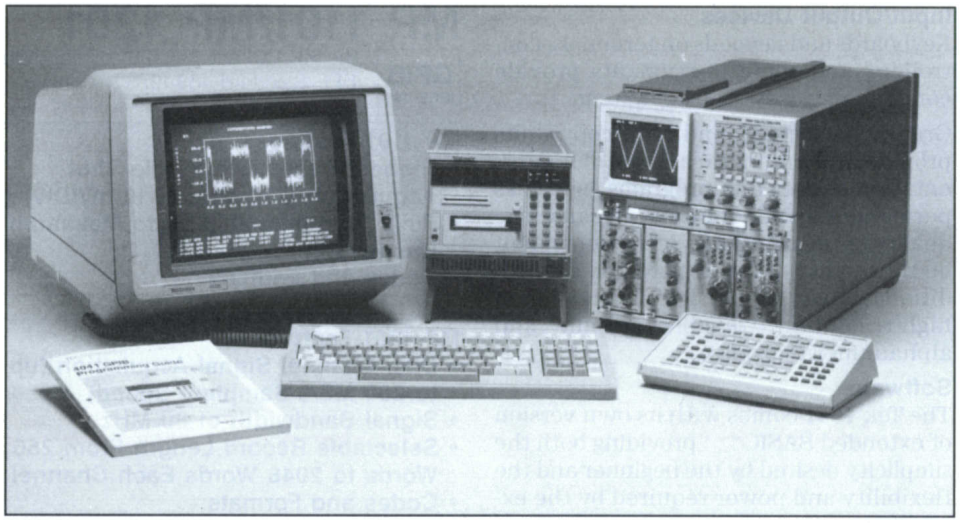
INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American, 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

For additional information on alternative mounting configurations, contact your local Tektronix Sales Office and ask for a Sales Engineer.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is in Customer Training section. For further information, or to enroll, call us at 1-800-835-9433 ext. 430. In Oregon, call collect 1-629-1017. For international orders, contact your nearest Sales Office.



MP2501

MP 2501

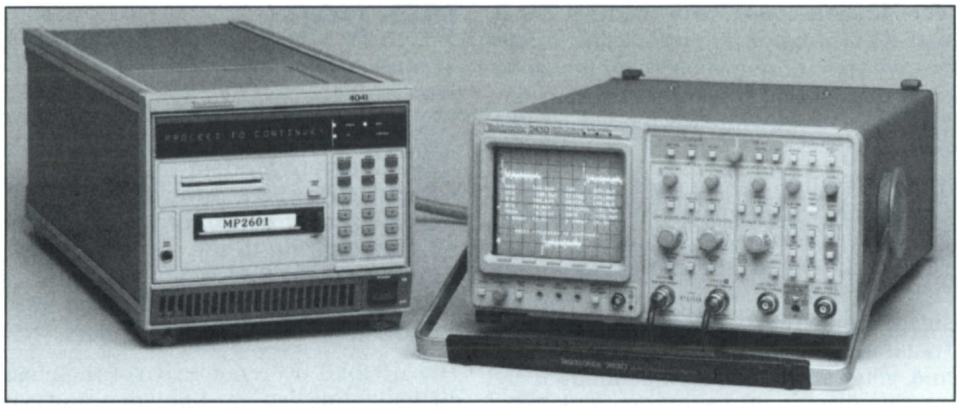
GPIB IEEE-488

The MP 2501 complies with IEEE Standard 488-1975.

7854 Waveform Processing Oscilloscope
- **DC to 400-MHz Bandwidth at 10 mV/Div**
- **Stores Repetitive Waveforms up to 400 MHz (up to 14 GHZ with Sampling Plug-Ins)**
- **Single-Shot Events and Pretrigger up to 50 μs/Div with 7B87 Time Base**
- **Enhanced BASIC Language—Resident 4041 BASIC with Numerous Extensions**

The MP 2501 Acquisition/Processing Measurement Package is based on the Tektronix 7854 Waveform Processing Oscilloscope, and is designed for signal acquisition, analysis, and processing of repetitive waveforms up to 400 MHz, or up to 14 GHz with optional sampling plug-ins. It provides flexibility for making controller-assisted measurements in fiber-optic testing environments using Tektronix sampling plug-in units. The 4696 Color Ink-Jet Printer is a particularly useful option with this package.

The MP software complements the built-in waveform processing and analysis features of the 7854 with menu-driven functions such as Correlate, Convolve, FFT, Differentiate, Integrate, and Taper. The MP software also greatly facilitates the storage and retrieval of waveforms and 7854 programs via mass media. The software can control up to 14 7854s (up to 28 with the optional second IEEE-488 bus.)



CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature—+10 to +35°C (+50 to +95°F).
Thermal Output—Approximately 2750 BTU/hr.
Operating Altitude—4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage—115 V (nominal).
Line Frequency—60 Hz.
Maximum Power Consumption—800 W (nominal).

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2501 Acquisition/Processing Measurement Package (Order appropriate 7000-Series plug-ins, such as 7A16A and 7B80. See 7000-Series Plug-Ins section.) **$24,500**
Includes: 7854, 4041, 4205, software.

OPTIONS

Option 10—Substitute Tektronix 4207 Color Graphics Terminal for 4205. **+$1,500**
Option 18—Add Tektronix 4696 Color Ink-Jet Printer. **+$1,795**
Option 22—Adds Option 01 to 4041 (second GPIB interface and second RS-232C port) This option is not available with Option 23. **+$1,200**
Option 23—Adds Option 03 to 4041 (disk interface and second RS-232C port). This option is not available with Option 22. **+$1,000**
Option 26—Adds 4041DDU (10 Mb hard disk and 5¼ in. flexible disk). Requires Option 23. **+$1,995**

OPTIONAL ACCESSORY

Recommended Cart—(For 7854 and 4041) K213 Option 10 Lab Cart with keyboard drawer for the 7854 and lower shelf for the 4041. See Accessories section for a complete description. Order K213 Option 10 **$820**

MP 2601

GPIB IEEE-488 The MP 2601 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Two Channels Simultaneous Acquisition**
- **100-MHz Sample Rate for Single-Shot Acquisition**
- **150-MHz Bandwidth for Repetitive Signals**
- **Envelope Mode for 2-ns Glitch Capture at Any Sweep Speed**
- **Signal Averaging to Pull Signals Out of Noise**
- **Extensive Triggering Capabilities**
- **Event Capture on Trigger Events or When Signal Exceeds Predefined Limits**
- **Data Logging Upon Demand, With Each Trigger Event or When Signal Exceeds Predefined Limits**
- **Extensive Time and Amplitude Measurements**
- **Signal Processing and Data Manipulation to Match Measurement Requirements**
- **Ease of Use Via Menu-Driven Control**

The MP 2601 Portable Measurement Package provides extensive signal acquisition capabilities with signal analysis and forms a system directed at measurement solutions.

Functions:

- Reference waveform to file transfers 46 files (100 files, Option 29)
- Files to reference waveforms transfer
- Event capture
- 20 parameters on waveforms (top, base, distal, mesial, proximal, min, max, peak to peak, mid, mean, top overshoot, base overshoot, rise, fall, width, duty cycle, period, 1/period, RMS, and area)
- Waveform mathematics (add, subtract, multiply, divide, integrate, 2-point differentiation, 3-point differentiation, smoothing, FFT, correlate, add scalar, and multiply by scalar)
- Application programs
- Environmental parameters

ORDERING INFORMATION

MP 2601 Portable Measurement Package **$15,650**
Includes: 4041 (with Option 10); 2430A; IEEE-488 cable; S45F601 Software Package.

OPTIONS

Option 05—Video Trigger. **+$1,050**
Option 11—Probe Power. **+$165**
Option 18—Add 4696 Ink-Jet Printer. **+$1,795**
Option 19—Add 4644 Printer. **+$695**
Option 22—Adds Option 01 to 4041 (second GPIB interface and second RS-232C port). This option is not available with Option 23. **+$1,200**
Option 23—Adds Option 03 to 4041 (disk interface and second RS-232C port). This option is not available with Option 22. **+$1,000**
Option 26—Adds 4041DDU (10 Mb hard disk and 5¼ in. flexible disk). Requires Option 23. **+$1,995**
Option 29*1—Adds disk-based implementation to provide greater functionality. Incorporates Options 23/26. Includes S45F602 software. **+$3,195**
Option 30—Adds Option 30 to 4041 (program development ROMS & carrier). **+$995**
Option 31—Adds Option 31 to 4041 (program development keyboard). **+$550**
Option 32—Add 4205. **+$2,995**
Option 35—Add 4207. **+$3,995**
Option 36—Add 4208. **+$8,995**

*1 *To order, contact your local Tektronix Sales Office.*

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

TRAINING

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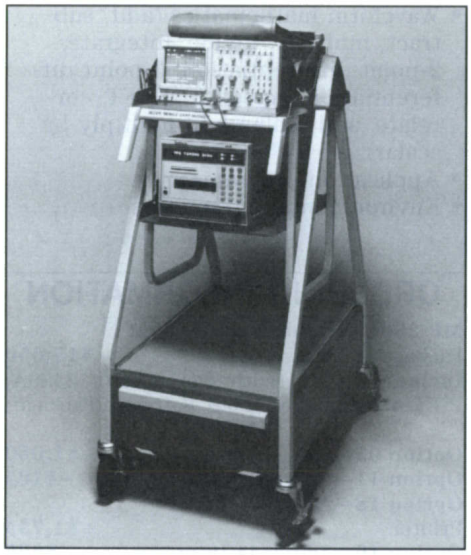

MP 2601 on a K213 Instrument Cart.

NEW MP 1701/ MP 2701

GPIB IEEE-488 — The MP 1701 and MP 2701 comply with IEEE Standard 488-1978.

- **High-resolution, 10-bit Waveform Digitizing with Autocalibrated ±0.4% Gain Accuracy**
- **200 Megasamples/Second Real-Time Digitizing with 100-MHz Bandwidth**
- **Dual-Channel Acquisition and Display**
- **Record Lengths from 1K to 64K Waveform Points**
- **Up to Five Sample-Rate Changes in any Record**
- **Extensive Cursor Measurement Capabilities**
- **Vertical and Horizontal Display Zoom**
- **Versatile Acquisition/Record/Trigger Modes**
- **Front-Panel Control of all Features Plus Full IEEE-488 Programmability**
- **Nonvolatile Storage of 10 Complete Front-Panel Setups**
- **TV Triggering Option**

The MP 1701 and MP 2701 are based on the RTD 710 Programmable Waveform Digitizer. These packages are designed for signal-measurement applications that require dual-channel acquisition with high accuracy and resolution, longer record lengths, and analog bandwidths of up to 100 MHz.

The MP 1701 comes with the RTD 710, a 620 XYZ Monitor, cabinet, cables, and hardware. Without a controller, it can be used under local control, or can be added to systems that already include a GPIB controller.

The MP 2701 adds the 4041 Instrument Controller with Signal Processing and Program Development firmware, a 4041 DDU Disk Drive Unit, and a 4205 Color Graphics Terminal. This package supports signal acquisition and storage, waveform transforms, measurement parameters, and general utilities complemented by graphic display of waveforms and data. The MP 2701 also supports user-defined macros to allow tailoring of the program's execution to user-specified measurement requirements.

ORDERING INFORMATION

MP 1701 Waveform Acquisition, Measurement, and Viewing Package **$22,950**
Includes: RTD 710; 620; cables; mounting hardware; accessories; cabinet.

MP 2701 Waveform Acquisition, Measurement, Viewing, and Analysis Package **$36,750**
Includes: RTD 710; 4041 w/Opts 03, 10, and 30; 4041DDU; 4205; 620; cables; mounting hardware; accessories; cabinet.

OPTIONS

Option 1D—Delete Cabinet. **−$750**
Option 1P—Add 2 ea. P6106A Probes **+$250**
Option 2D—Delete RTD 710 Fron Panel **−$500**
Option 05—Add TV Trigger to RTD 710 **+$1,500**
Option 10—(MP 2701) Substitute 4207 for 4205. **+$1,500**
Option 18—(MP 2701) Add 4696 Color Copier **+$1,795**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

MP 2901

GPIB IEEE-488 — The MP 2901 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **A General-Purpose IEEE-488 Development System**
- **Rapid, Error-Free Software Development by Nonprogrammers**
- **Easy Fixturing to the Device-Under-Test**
- **Compatible With IEEE Standard 488 Equipment from Most Suppliers**

The MP 2901 overcomes two of the most difficult hurdles in implementing an automated system—writing the test software and interfacing the IEEE 488 system to the unique device-under-test.

The task of software development is dramatically reduced with TEK EZ-TEST software. This software is a high-level, menu-driven program that allows even nonprogrammers to create test software. The generated BASIC code is error-free and structured (to allow easy long-term maintenance). TEK EZ-TEST is powerful and flexible. It supports "learn mode" found in Tektronix instruments for exceptionally easy instrument set-up. Naturally, TEK EZ-TEST has the ability to accept IEEE-488 instruments from other manufacturers as well. The test programs generated are standalone 4041 BASIC programs so TEK EZ-TEST generated programs can be tailored to meet even the most unique test requirements.

The MI 5010/MX 5010 provide A/D, D/A, digital I/O, scanning, switching, and other functions using high-level commands. With these functions, the task of stimulating/measuring/switching the device-under-test and the test instruments is made easy because the MI 5010/MX 5010 handle the interface between the device-under-test and the IEEE-488 bus.

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature—+10 to +35°C (+50 to +95°F).
Operating Altitude—4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage—115 V (nominal).
Line Frequency—60 Hz.
Maximum Power Consumption—970 W.

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2901 Inspection Test Station **$17,950**
Includes: 4041, 4205, TM 5006, MI 5010/MX 5010; extender; PS 5010, TEK EZ-TEST Software.

OPTIONS

Option 03—Delete MI 5010, MX 5010, PS 5010. **−$6,200**
Option 1A—Add 50M10 A/D Converter Card. **+$895**
Option 1B—Add 50M20 D/A Converter Card. **+$910**
Option 1C—Add 50M30 Digital I/O Card. **+$495**
Option 1D—Add 50M40 Relay Scanner Card. **+$695**
Option 1E—Add 50M41 Low Level Scanner Card. **+$995**
Option 1F—Add M41A1 Low Level Amplifier. **+$550**
Option 1G—Add 50M50 16K Buffer Memory Card. **+$995**
Option 1H—Add 50M70 Development Card. **+$410**
Option 10—Substitute 4207 Color Graphics Terminal for 4205. **+$1,500**
Option 18—Add 4696 Color Ink-Jet Printer. **+$1,795**
Option 19—Add 4644 printer. **+$695**
Option 2A—Add TM 5006 Mainframe with Option 02 and 2-m GPIB Cable. **+$1,295**
Option 2B—Add TM 5006 Mainframe with Option 12 and 2-m GPIB Cable. **+$1,395**
Option 2C—Add DM 5010 4½-Digit Digital Multimeter. **+$2,260**
Option 2D—Add FG 5010 20-MHz Function Generator. **+$3,995**
Option 2E—Add SG 5010 Oscillator. **+$4,195**
Option 2F—Add PS 5010 ±32-V Triple Power Supply. **+$3,050**
Option 2G—Add PS 5004 20-V Precision Power Supply. **+$1,850**
Option 2H—Add DC 5010 350-MHz Digital Counter. **+$4,610**
Option 2J—Add SI 5010 16-Channel, 350 MHz Scanner. **+$2,275**
Option 2K—Add MI 5010 Multifunction Interface. **+$1,760**
Option 2L—Add MX 5010 Interface Extender. **+$740**
Option 2M—Add DC 5009 135-MHz Digital Counter. **+$2,775**
Option 22—Add Option 01 to 4041 (second GPIB Interface and second RS 232C port). This option is not available with Option 23. **+$1,200**
Option 23—Add Option 03 to 4041. (Disk Interface and second RS-232C port). This option is not available with Option 22. **+$1,000**
Option 26—Adds 4041DDU (10 Mb hard disk and 5¼ in. flexible disk). Requires Option 23. **+$1,995**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

TRAINING

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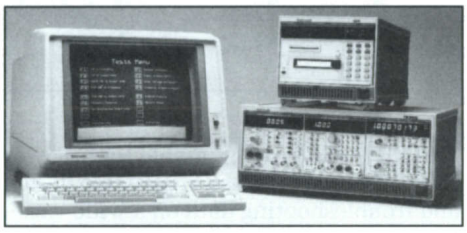


MP 2902

GPIB IEEE-488

The MP 2902 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Eleven Comprehensive Audio Tests**
- **Rapid, Error-Free Test-Program Development by Nonprogrammers**
- **State-of-the-Art Measurement Performance**
- **Software Supports All IEEE Standard 488 Instruments and Provides for Unique Test Requirements**

The MP 2902 Audio Measurements Package makes critical audio measurements consistently, accurately, and quickly. The Tektronix Audio Test Program Generator (Audio TPG) produces automated test procedures quickly and easily. This software-development tool dramatically simplifies the process of converting manual tests into software. With the Audio TPG, menus guide nonprogrammers through test development. The result is error-free code written in 4041 BASIC. Tests supported in the Audio TPG include: THD vs Frequency, THD vs Output Level, IMD vs Output Level (SMPTE or CCIF), CCIF IMD vs Frequency, Frequency Response, Signal-to-Noise, Level (Voltage and Power), Linearity, and External Stimulus. Provisions are made for the user to add any unique testing requirements not directly supported in the Audio TPG.

Whether the environment is production or R&D and whether the test requirement is microphone characterization, broadcast station proof-of-performance, or measuring noise and distortion of audiotype machines, the MP 2902 offers accuracy, speed, and consistency.

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature—+10 to +35°C (+50 to +95°F).
Operating Altitude—4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage—115 V (nominal).
Line Frequency—60 Hz.
Maximum Power Consumption—970 W.

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2902 Audio Measurements Package **$16,490**
Includes: 4041; 4205; TM 5006; AA 5001; SG 5010; software.

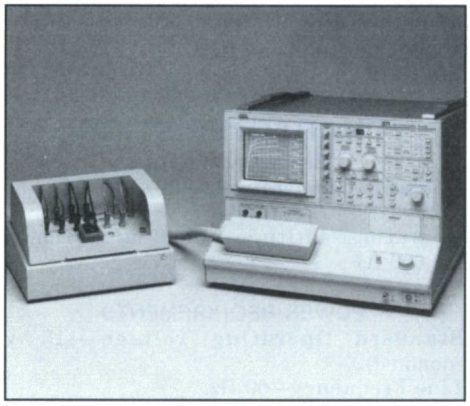
OPTIONS

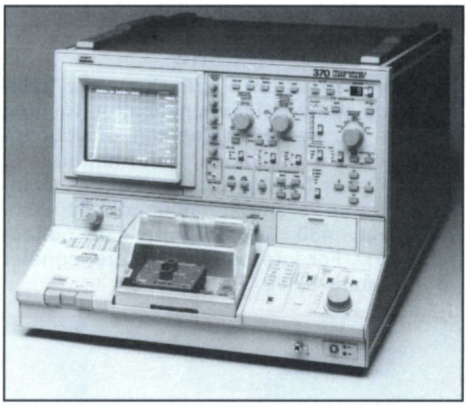
Option 1J—Substitute AA 5001. Option 02 (CCIR/DIN) for AA 5001. **+$410**
Option 10—Substitute 4207 Color Graphics Terminal for the 4205 Color Graphics Terminal. **+$1,500**
Option 18—Adds 4696 Color Ink-Jet Printer. **+$1,795**
Option 19—Adds 4644 Dot Matrix Printer. **+$695**
Option 2H—Adds DC 5010 Programmable Universal Counter/Timer. **+$4,610**
Option 22—Adds Option 01 to 4041 (second GPIB Interface and second RS-232C port). This option is not available with Option 23. **+$1,200**
Option 23—Adds Option 03 to 4041 (Disk Interface and second RS-232C Port). This option is not available with Option 22. **+$1,000**
Option 26—Adds 4041DDU (10 Mb hard disk and 5¼ in. flexible disk). Requires Option 23. **+$1,995**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

CURVE TRACERS

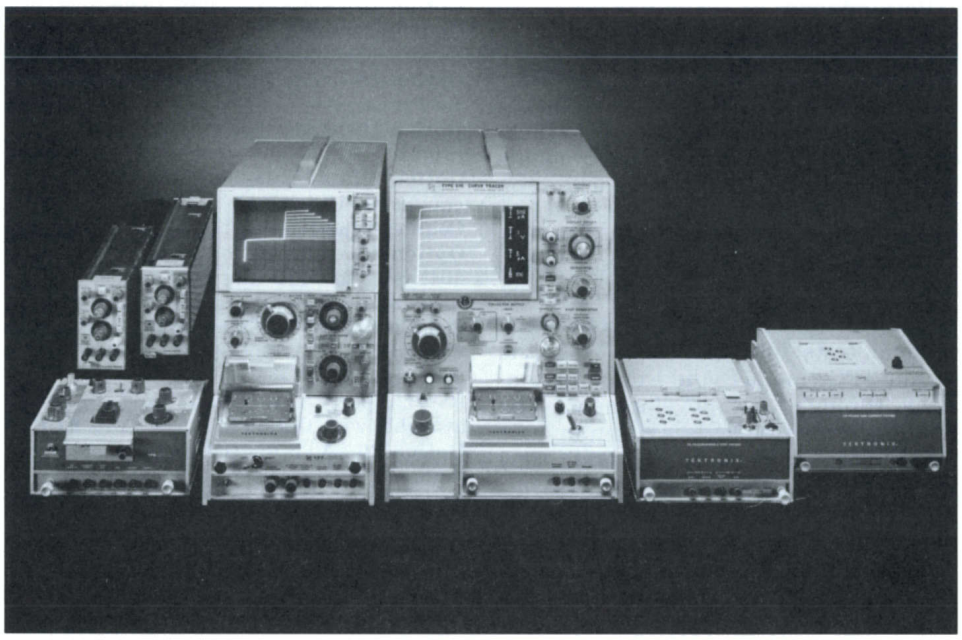




CONTENTS

Programmable Curve-Tracer Systems 407
System Software 411
576 Curve-Tracer System 412
176 Pulsed High-Current Fixture . 412
577/177 Curve-Tracer System 414
178 Linear-IC Test Fixture 416
Socket Adapters 418
5CT1N and 7CT1N Curve-Tracer Plug-Ins 419

The NEW 371 Programmable High-Power Curve Tracer gives fast, repeatable design and troubleshooting data on a wide variety of semiconductor devices. In particular, the 371 is optimized for testing high-power devices and for making relatively high-power tests on more conventional devices, such as bipolar transistors, and FETs. The 371 is ideal for testing solid-state switches and control devices in applications like switching regulators and motor controls.



Pulsed power supplies allow testing devices at peak power limits without overheating or damaging the device under test.

The 370 Programmable Curve Tracer delivers comprehensive information on a range of semiconductor devices and integrated circuits—from two-, three-, and four-terminal devices such as diodes (signal, rectifier, zener); transistors (bipolar, FET); thyristors (SCR, UJT, Triac) to optoelectronic (optoisolator, photodetector), and ICs.

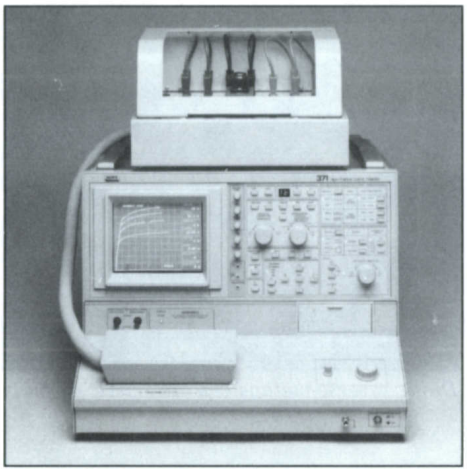
Like other curve tracers, the 370 and 371 reveal more than pinpointed parameters. They show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

In addition, the 370 and 371 offer all the benefits of programmable instrumentation, from curve storage to precise repetition of test parameters and data; from automatic test sequencing to various comparisons of device behavior at different points in time—all with the added capability of computerized control and analysis.

The 576 and 577 Curve Tracers use standard plug-in test fixtures for a variety of low- or high-current applications. The 176 Pulsed High-Current Fixture is designed for use in the 576. The 178 Linear-IC Test Fixture is designed for use in the 577.

The 5CT1N and 7CT1N plug-in units are designed for use in the 5000-Series and 7000-Series oscilloscopes, respectively.

The following Curve-Tracer System descriptions will help you choose the system that best meets your requirements. Additional information is available. Contact your local Sales Engineer.



New 371 High-Power Programmable Curve Tracer

370/NEW 371

Programmable Curve Tracers

GPIB IEEE-488 — The 370 and 371 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Digitized Waveforms**
- **Bubble-Memory Storage**
  - **Store 16 Test Set-Ups**
  - **Store 16 Families of Curves**
- **GPIB and Plotter Interfaces**
- **Test Sequencing Without Controller**
- **Waveform Comparisons**
- **Display/Waveform Cursors**
- **Displays 24 Characters of Text**
- **On-Screen Readout of Control Settings/Cursor Values**
- **Maximum Volts 2000 (370) and 3000 (371)**
- **Vertical Sensitivity 100 pA/Div (1 pA Resolution) (370)**
- **3 kW Collector Power-Supply Capability (371)**
- **20-A or 50-V Base Drive (371)**

370, 371 TYPICAL APPLICATIONS

Automated Semiconductor Manufacturing Processes
Incoming Inspection
Production Device Testing
Semiconductor R & D

371 TYPICAL APPLICATIONS

Nondestructive Breakdown Tests
High-Power Semiconductor Evaluation

Program Control

The 370/371 are programmable via the IEEE Standard 488 General Purpose Interface Bus (GPIB). This interface provides remote control and automated acquisition of curve data. You can send characteristic-curve data in either direction over the bus (from the 370/371 to the controller, or vice versa).

When using a controller, you can remotely control the front panel except for controls intended for local use only (such as Intensity). The GPIB complies with Tektronix' Interface Standard for GPIB Codes, Formats, Conventions, and Features.

Digitized Waveforms

Display modes are selected by pushbuttons labeled Nonstore, Store, Compare, View, and Enter. When you select Nonstore, the 370/371 operate like conventional curve tracers. When you choose Store, the 370/371 display digitized characteristic curves with a bright, flicker-free trace. The Enter button lets you put the digitized display into bubble memory. The View button recalls displays from memory. With Compare mode, you contrast characteristic curves by displaying Store and View curves simultaneously.

Bubble Memory

The 370/371 provide nonvolatile memory via a bubble-memory cassette plugged into a front-panel opening. Each cassette can store 16 families of curves and 16 front-panel set-ups. This storage technology is virtually impervious to the dust and grime that impair other storage-media performance, making the 370/371 ideal for harsh environments like factory floors and incoming-inspection areas.

Front-Panel Set-Up

The 370/371 can store 16 sets of front-panel-control settings and recall them later. Pressing the Save button saves all current front-panel settings in bubble memory. Pressing Recall restores the front-panel settings that were previously saved.

With stored set-ups, you can easily cycle through a series of tests—either semi-automatically, by pressing front-panel controls to begin each test, or automatically, under program control.

Test Sequencing

You can sequence through as many as 16 device tests from the front panel without using a controller.

Performance Conditions

The following electrical and environmental characteristics are valid for instruments operated at ambient temperatures from +10 to +40 °C after an initial warm-up period of 20 minutes, when previously calibrated at a temperature from +15 to +25 °C.

371 CHARACTERISTICS

COLLECTOR SUPPLY

Modes/Polarity—High-Current: +pulses, − pulses. High Voltage: + rectified sine wave, − rectified sine wave.

Maximum Peak Voltage and Voltage Accuracy

Peak Power Range (W)	3 k*1	300*1	30*2	3*2
Minimum Collector Current Available (A)	400	40	40 m	4 m
Maximum Peak Collector Voltage (V)	30	30	3 k	3 k
Accuracy (%)	+10, −5	+10, −5	+10, −0	+10, −0

*1 *Pulsed collector supply.*
*2 *Sine-wave collector supply.*

Pulsed Collector Supply—300 μsec ±10% pulse width; 0.25X line-frequency repetition rate.

STEP GENERATOR

Current Mode—Normal step, 1 μA to 2 mA in 1-2-5 sequence with Peak Power at 30 or 3 W. Pulsed Step, 1 mA to 2 A in 1-2-5 sequence with Peak Power at 3 kW or 300 W. Maximum current is 10X step amplitude ±2%. Maximum voltage is 12 V ±20%.
Voltage Mode—200 mV to 5 V in 1-2-5 sequence. Maximum current is 100 mA. Maximum voltage is 10X Step Amplitude.
Step Rate—0.25X line frequency at 3 kW and 300 W. 1.0X line frequency at 30 and 3W.
Pulsed Current Steps—Pulse width, 500 μsec ±10%; rise and fall times, ≤40 μsec.

VERTICAL DISPLAY SYSTEM

Collector Current—Range, 500 mA to 50 A/div in 1-2-5 sequence at 3 kW and 300 W or 10 μA/div in 1-2-5 sequence at 30 and 3 W. Accuracy, ±0.1 div. Cursor accuracy, ±2% of readout +0.2 div in Nonstore mode and ±1.5% of readout +0.1 div in Store mode.

HORIZONTAL DISPLAY SYSTEM

Collector Supply—500 mV to 5 V/div in 1-2-5 sequence at 3 kW and 300 W or 50 to 500 V/div in 1-2-5 sequence at 30 and 3 W.
Step Generator—100 mV to 5 V/div in 1-2-5 sequence.
Accuracy—±0.1 div.
Cursor Accuracy—Within 2% of readout +0.2 div in Nonstore mode or 1.5% of readout +0.1 div in Store Mode.

DIGITAL STORAGE SYSTEM

Resolution—100 points/div or 1024 points maximum, horizontally and vertically.
Sample Rate—0.125X line frequency to 1024X line frequency.

CRT AND READOUT

CRT—7-in. diagonal, electrostatic display, P31 phosphor. 1000×1000 total addressable pixels.
Readout—Automatic on-screen display of scale factors and Beta or g_m/div. 24 characters of text can be displayed and updated via GPIB to annotate test.

INTERFACES

GPIB—IEEE Standard 488-1978 implemented as: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, and L0.
Plotter—8-bit parallel (Centronix) supporting HPGL-compatible plotters.

TEST FIXTURING

The Test Fixture Unit is a standard accessory that provides a safety enclosure for the device under test (DUT). I prevents the operator from contacting dangerous voltages while the DUT is being tested. The Test Fixture Unit accommodates devices as large as 8×5×4.75 inches (203×127×120 mm), and connects to the main unit via a cable/plub assembly. Kelvin sensing adapters A1001 thru A1005 (see page 418) plug into the Test Fixture Unit.

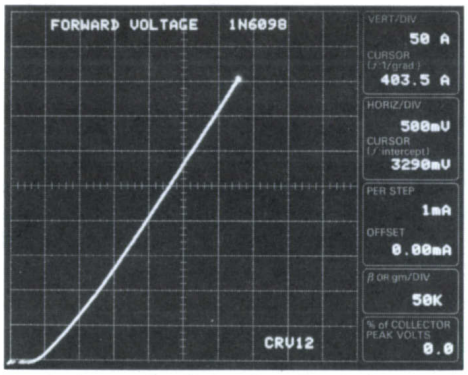
Users wishing to construct their own fixturing should order the optional Field Wiring Cable (cable/plug assembly without test fixture enclosure).

POWER REQUIREMENTS

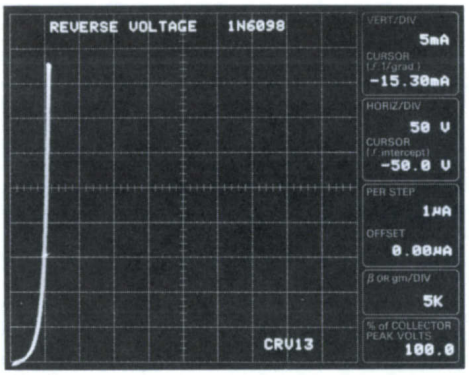
Line-Voltage Ranges—90 to 132 V ac or 180 to 250 V ac.
Line-Frequency Range—48 to 63 Hz.
Maximum Power—400 W, 2 A.

PHYSICAL CHARACTERISTICS

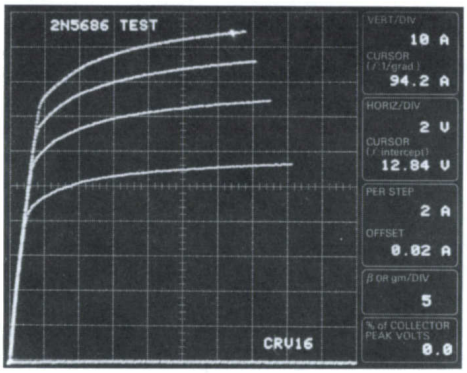
Dimensions	mm	in.
Height	332	13.1
Width	429	16.9
Depth	637	25.1
Weight ≈	**kg**	**lb**
Standard	36	79.4



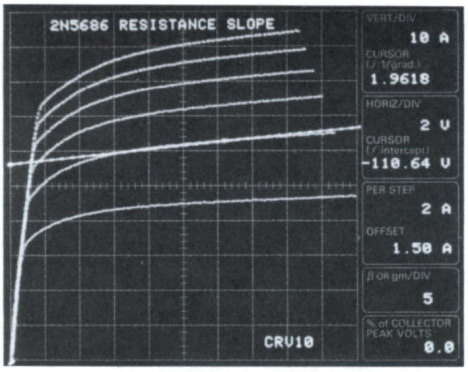
Diode forward-voltage characteristic curve.



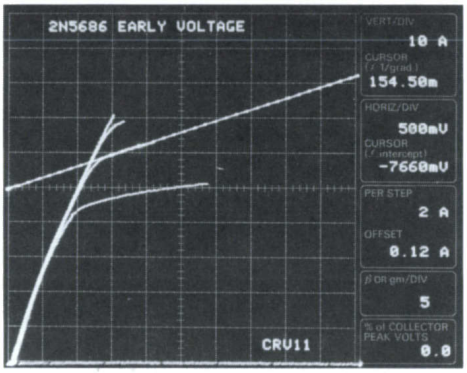
Diode reverse-voltage characteristic curve.



Bipolar-transistor family of curves created using the 371's sweep mode.



F-line cursor used to calculate and display resistance slope (1.96 Ω).



F-line cursor used to calculate and display early voltage (−7.66 V).

370 CHARACTERISTICS

COLLECTOR SUPPLY

Polarity/Modes—Select from these seven modes of collector-supply operation: AC at line frequency; + (positive full-wave rectified); − (negative full-wave rectified); +DC (positive dc); −DC (negative dc); +Leakage (positive dc, emitter current); −Leakage (negative dc, emitter current).

Maximum Peak Voltage and Voltage Accuracy—Peak open-circuit voltage on all ranges within +10%, −0%, at Max Peak Power of 50 W. See table below.

Peak Power—0.08, 0.4, 2, 10, 50, and 220 W.

Variable Collector Supply—0 to 100% in 0.1% increments.

Safety Interlocks—A protective cover must be in place over test terminal and lid shut before you can apply collector voltage.

Step-Generator Display—Range is 1 or 10 steps/div, or 1 step/10 div. Unmagnified and magnified accuracy are within 3%.

Display Offset—Vertical offset of display centerline value up to 10 div in 21 half-div steps.

STEP GENERATOR

Current Mode—Amplitude Range: 50 nA to 200 mA in 1-2-5 sequence in 21 steps, selected by Step/Offset Ampl. Max current is 20X step amplitude, except for 2 A when switch is set to 200 mA. Max voltage is at least 10 V. Max opposing offset current is 10X step amplitude. Max opposing volts are less than 7 V. Ripple plus noise is less than 0.5%X step amplitude +1 nA.

Voltage Mode—Amplitude Switch Range: 50 mV to 2 V, in 1-2-5 sequence. Max Voltage: 20X step amplitude. Max Current: At least 2 A at 10 V or less, or 10 mA at 40 V.

Accuracy (Current or Voltage Steps Including Offset)—Incremental 2%. Absolute is less than 2%X total output +3%X amplitude setting.

Offset Control—Variable from −10 to +10X step amplitude, with 0.1% resolution.

Short-Circuit Current Limiting—Selected by current-limit switch: 20 mA, 100 mA, 500 mA, 2 A (+50%, −20%).

Maximum Opposing Offset Volts—10X step amplitude.

Maximum Opposing Current—Less than 10 mA.

Step Rates—2X line frequency (1X line frequency in ac collector supply). Steps occur at 0 collector voltage.

Pulsed Steps—80 or 300 μs wide ±10%.

Steps and Offset Polarity—Same as collector-supply polarity when step-generator polarity invert is disabled. Opposite to collector-supply polarity when step-generator polarity invert is selected or configuration switch is set to base grounded. If configuration is set to base grounded, step-generator polarity invert is disabled.

Number of Steps—Selectable from 0 to 10.

Auxiliary Supply—Range: −40 to +40 V with 20-mV resolution. Accuracy: Less than 50 mV +2% of total output. Output Current: At least 100 mA ±20 V; at least 10 mA ±40 V.

Nonstore Mode—Collector Current: Range is 1 μA to 2 A/div in a 1-2-5 sequence of 20 steps. X10 Mag extends max sensitivity to 100 nA/div (1 nA resolution). Both unmagnified and magnified accuracy are within 3%. Emitter Current: Range is 1 nA to 2 mA/div in 1-2-5 sequence of 20 steps. X10 Mag extends max sensitivity to 100 pA/div. Both unmagnified and magnified accuracy are within 3%.

Digital-Storage Vertical Acquisition—A/D Converter: Resolution is 10 bits for 10.24 divisions, 100 counts per division. Maximum data points are 1024. Maximum sampling rate is line frequency X1024. Minimum sampling rate is line frequency X2. Collector Current: Range is 1 μA to 2 A/div in a 1-2-5 sequence of 20 steps. X10 mag extends max sensitivity to 100 nA/div (1-nA resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor. Emitter Current: Range is 1 nA to 2 mA/div in a 1-2-5 sequence of 20 steps. X10 mag extends max sensitivity to 100 pA/div (1-pA resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting +1 nA with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor.

Nonstore Horizontal-Deflection System—Collector Volts: Range is 50 mV to 500 V/div in a 1-2-5 sequence of 21 steps. X10 mag extends max sensitivity to 5 mV/div (50-μV resolution). Unmagnified and magnified accuracy are within 3%. Base/Emitter Volts: Range is 50 mV to 2 V/div in a 1-2-5 sequence of 6 steps. X10 mag extends max sensitivity to 5 mV/div (50-μV resolution). Unmagnified and magnified accuracy are within 3%. Step Generator Display: Range is 1 or 10 steps/div, or 1 step/10 div. Unmagnified and magnified accuracy are within 3%. Display Offset: Horizontal offset of display centerline value up to 10 div in 21 half-div steps.

Digital-Storage Horizontal Acquisition—A/D Converter Acquisition: Resolution is 10 bits for 10.24 div, 100 counts per div. Sampling rate is 2 to 1024X line frequency. Collector Volts: Range is 50 mV to 500 V/div in a 1-2-5 sequence of 21 steps. X10 mag extends max sensitivity to 5 mV/div (50-μV resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor. Base/Emitter Volts: Range is 50 mV to 2 V/div in a 1-2-5 sequence of 6 steps. X10 mag extends max sensitivity to 5 mV/div(50-μV resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor. Acquisition Modes (Normal, Envelope, and Average): Envelope is vertical or horizontal. Average is moving average with weight of $^1/_4$ or $^1/_{32}$.

Parameters vs. Voltage Ranges

Range (V)	16	80	400	2000
Max Peak Current (A)	10	2	0.4	0.05
Peak Current Pulsed (A)	20	4	0.8	0.1
Min Series*1 Resistance (Ω)	0.26	6.4	160	20 k
Max Series*1 Resistance (Ω)	800	20 k	500 k	12.5 M

*1 *Series resistance: available from 0.26 Ω to 12.5 MΩ (±5% or ±0.1 Ω).*

CRT

CRT—7-in. diagonal (173 mm), electrostatic deflection, GH (P31) phosphor.
Readout—Automatic on-screen display. Overrange is shown by a flashing display. 100 pA to 2 A/vertical div; 5 mV to 500 V/horizontal div; 5 nA to 200 mA and 5 mV to 2 V per step.
BETA or g_m/Division—500 nano to 400 mega for Beta and 50 S to 400 S for g_m. Cursor is 4-digit horizontal and vertical values without X10 mag, 5-digit with mag. Offset is 4-digit value. Auxiliary supply is −40 to +40 V.
Text Display—Text characters are alphanumeric fonts 1, accessible via GPIB; SP,!, . . . A,B, . . . 0,1,9,/, . . . a,b, . . . y,z, . . . ; u is recognized as micro. Or: Alphanumeric fonts 2, accessible via front panel; A,B, . . . , Y,Z,(space), m,u,n,p,,,0,1, . . . 9,-,/,*,(,); u is recognized as micro.
Maximum Text Characters—24 letters.
Character Size—Approximately 3-mm high, 2-mm wide.

ELECTRICAL

	Maximum Output Voltage	Maximum Output Current
Base, Base Sense; Emitter, Emitter Sense	±40 V	±20 A
Connectors		
(Collector, Collector Sense) Adapter Connectors	±2000 V	±20 A
Step Gen Out Connector	±40 V	±2 A
Aux Supply Connector	±40 V ±20 V	@ ±10 mA @100 mA
Ext Base or Emitter Connector	±40 V	±2 A

POWER REQUIREMENTS

Line-Voltage Ranges—115 or 230 V ac. High: 107 to 132 V ac, 214 to 250 V ac. Low: 90 to 110 V ac, 180 to 220 V ac.
Line-Frequency Range—48.0 to 66.0 Hz.
Power Consumption—Maximum: 400 W, 3.5 A at 132 V, 60 Hz. Typical: 120 W, 1.3 A at 115 V, 50 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	429	16.9
Height	332	13.1
Depth	637	25.1
Weight ≈	**kg**	**lb**
Net, standard	35.0	77.0
Net, with Option 1R, Rackmount	36.0	79.2

ORDERING INFORMATION

371 High-Power Curve Tracer*1
Includes: Power cord (161-0066-00); bubble-memory cassette (020-1310-00); test fixture unit; In-line transistor adapter, Kelvin Sense (A1002); TO-3/TO-66 adapter, Kelvin Sense (A1003); operator's manual (070-6839-00); Pocket Reference Guide (070-6841-00).
370 Programmable Curve Tracer **$17,325**
Includes: Blank adapter, Kelvin Sense (A1001); In-line transistor adapter, Kelvin Sense (A1002); Axial lead diode, Kelvin Sense (A1005); 4 and 6 lead dual width transistor/FET (A1007); bubble memory cassette (020-1310-00); protective cover (337-3344-00); spare fuses 125 V/4 amp (159-0259-00); slow blow 250V/2 amp (159-0260-00); power cord (161-0066-00); Operator's manual (070-6064-00); Instrument Interfacing Guide (070-6067-00); Pocket Reference Guide (070-6066-00).

OPTION

Option 1R— Rackmount **+$415**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

371 OPTIONAL ACCESSORIES

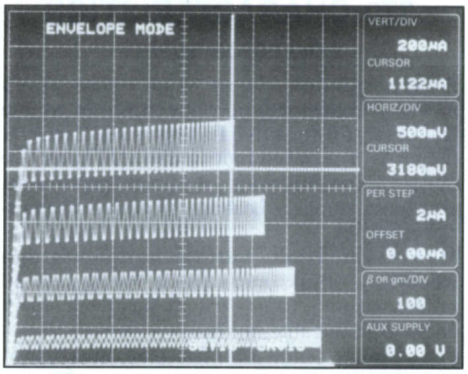
Service Manual
Order 070-6840-00*1
GPIB Cable (012-0991-00) **$155**
Plotter Cable*1
External Wire Fixture*1
HC100 Plotter*1 —Four pen color plotter. See Accessories section.

370 OPTIONAL ACCESSORIES

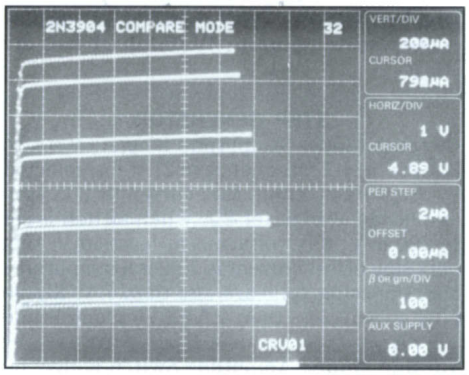
Service Manual—Order 070-6065-00 **$55**
Calibration Fixture—370 Maintenance. Order 067-1286-00 **$440**
Socket Adapters—See Curve-Tracer Socket Adapters in this section.
HC100 Plotter*1—Four pen color plotter. See Accessories section.
Cart—K217. See Accessories section.
*1 *To order, contact your local Tektronix Sales Office.*

CAMERAS

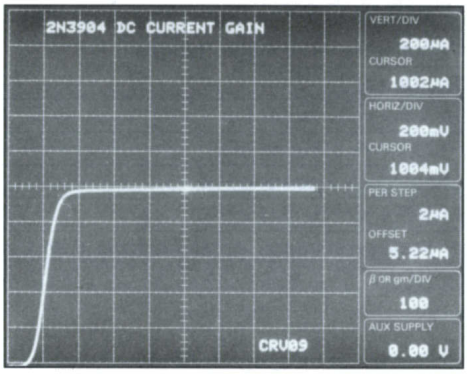
C-59A, C-5C, C-7—See Accessories section.



Envelope Mode and Crosshair Cursor—Capture and display maximum and minimum excursions of digitized curves. Detect subtle changes over time that you might otherwise overlook as, for example, DUT thermal drift. The crosshair cursor in this application shows predrift conditions.



Waveform Comparisons—Simultaneously display real-time characteristic curves of a DUT, along with a previously acquired family of curves that are digitally stored in internal memory. Thus, you quickly and conveniently compare the DUT with reference data.

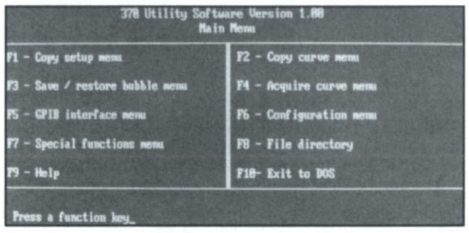


Dot Cursor Mode—Position an intensified dot cursor to any point on the waveform and read out the vertical and horizontal coordinates. The dot cursor is also useful when sending data over the GPIB.

The SONY®TEKTRONIX® 370 and 371 are manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 370 and 371 are available from Tektronix, Inc., its marketing subsidiaries, and distributors.

NEW 370 UTILITY SOFTWARE

- **Archives Curves, Front-Panel Settings, and Bubble Memory Contents to Disk**
- **Displays and Plots Acquired Curves**
- **Generates Test Programs Without Programming Skills**
- **Hard-Copy Dump of Numerical Test Results**
- **Example Test Programs Included**
- **Basic Source Code Available**



The 370 Utility Software links the 370 Curve Tracer to the IBM PC. Its menus provide easy-to-use access to features that simplify curve-tracer operations. Users can easily create customized device tests using their own test algorithms.

The 370-to-PC link offers unlimited mass storage for device test setups and displays. A complete test-setup library can be stored on disk. Curves can be stored on disk as well as displayed on the PC monitor or graphed to an HPGL compatible plotter.

A powerful feature of the utility software is its built-in test-program generator. Programming skills are not needed to create automatic device-test programs. Numerical test results can be displayed on the PC, sent to a printer for hardcopy, and recorded in a log file. Example programs are included that can easily be modified to test a broad range of device types. Writing and debugging test programs is easy with the use of an optional ASCII text editor.

HARDWARE

Required Hardware
IBM PC/XT/AT; DOS 2.0 or higher with 640K memory; dual floppy drive or 1 floppy and 1 hard disk; IBM color graphics card or EGA adapter (or compatible); National Instruments PC2 or PC2a GPIB card; GPIB cable.

ORDERING INFORMATION

370 Utility Software
Order S48P104 Option 01 **$695**
Includes: Software on 5¼ DS/DD disks and Manual.

NEW 370 DEVICE TESTING SOFTWARE

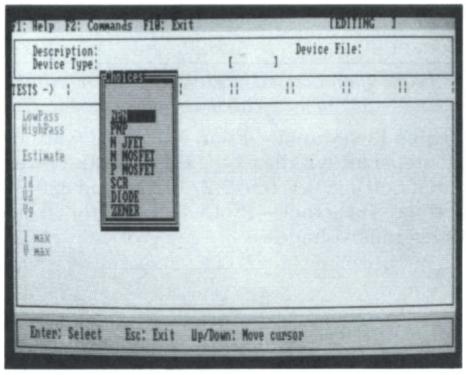
- **Automatic Measurement of BJT, FET, Diode, and MOSFET Characteristics**
- **Built-in Test Algorithms Eliminate the Need for Programming**
- **Minimizes Hands-On Curve-Tracer Operation**
- **Hard Copy Of Test Results**

The 370 Device Testing Software automates semiconductor testing. Test algorithms are built into the software, so there is no need to write test programs. Also, curve tracer knowledge is not necessary to begin device testing; the controller takes over the task of operating the 370. Running a complete device test is as simple as entering the device type; test results are only seconds away.

Pop-up windows prompt the user to select from a list of common device types such as bipolars, FETs, diodes, etc. Once a device type is specified, a number of common dc tests can be selected. Conditions and limits for each test are input using a spreadsheet format. Test files can be stored indefinitely on disk and reloaded simply and quickly. Once a test file is called, parameters like gain, breakdown voltage, and leakage are measured automatically.

By reducing setup and test time, the device-testing software offers significant labor savings in incoming inspection. Test-setup time is minimized because 370 front-panel setup and operation is not required. Shorter setup times make it practical to completely test one device before going on to the next. This eliminates the need for parallel testing and extra device handling.

Because the tests are automatic, the time per test is also reduced. Except for device insertion, virtually all other operator intervention is eliminated. Automatic and repeatable measurements provide high-quality device testing at a low cost per test.



HARDWARE

Required Hardware
IBM PC/XT/AT; DOS 2.0 or higher with 640K memory; dual floppy drive or 1 floppy and 1 hard disk; IBM color graphics card (or compatible); National Instruments PC2 or PC2a GPIB card; GPIB cable.

ORDERING INFORMATION

370 Device Testing Software
Contact your local Tektronix Sales Representative for price and delivery.

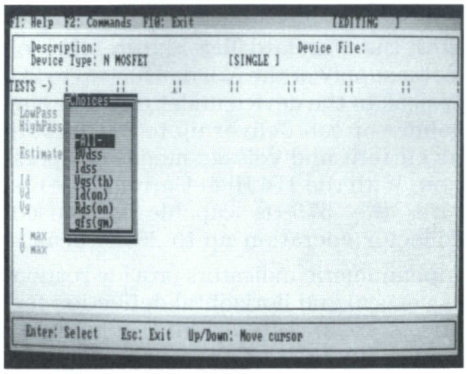
SYSTEMS

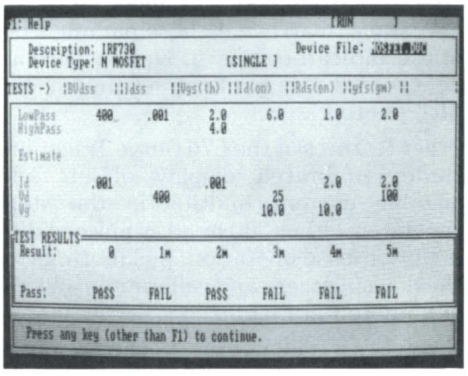
The new 370 software makes systems solutions possible for IC manufacturing process control areas.

Automatic GPIB Wafer Probing—Use the Device Testing Software with a GPIB Wafer Prober for automatic performance verification of IC test keys.

Failure Analysis on Multi-Pin Packages—Use the 370 and a TSI 8150 to automatically scan all pins of a packaged IC and determine which pins have faulty circuitry attached.

For information on Tektronix programmable measurement instruments or systems contact your local Tektronix Sales Representative.



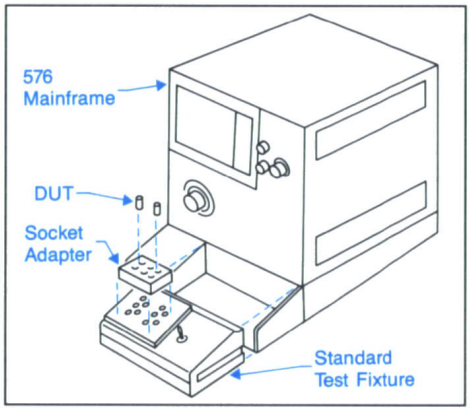


576/176

- **Tests Two- and Three-Terminal Discrete Semiconductors**
- **Power Capability Up to 220 Watts**
- **Convenient Scale-Factor Readout**
- **Test Fixture (Optional) for Testing Power Devices to 1000 Watts**

TYPICAL APPLICATIONS

Semiconductor R & D
Production-Device Testing
Incoming Inspection



176 High-Current Test Fixture (Optional)

The Tektronix 576 Curve-Tracer System continues to hold the title "standard of the industry." This general-purpose curve-tracer system performs well in applications where high-current testing is required.

With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 W peak to the device under test. The step generator can deliver up to 2 A in both its current and voltage modes of operation. With the 176 High-Current Test Fixture, the 576 is capable of pulsed-collector operation up to 200-A peak.

Alphanumeric indicators provide readout of vertical and horizontal deflection factors, step amplitude, and Beta/div or g_m/div. The Beta or g_m readout saves the operator from the arithmetic usually necessary to arrive at these parameters. These indicators also provide a permanent record of major knob settings in 576 CRT photographs.

Other features of the 576 Curve Tracer include: calibrated display offset; adjustable current limiting in the step generator; either 300 or 80 μs pulse width in pulsed-base operation; pushbuttons to check display zero and calibration; and an illuminated graticule.

A safety interlock protects the operator from dangerous voltages.

576 With Standard Test Fixture

576 CHARACTERISTICS

COLLECTOR SUPPLY

Modes/Polarity—Norm: AC (at line frequency); positive or negative full-wave rectified ac. DC: Positive or negative dc. Leakage: Emitter-current rather than collector-current measurements. 1000X increase in vertical-deflection sensitivity (1 nA/div).

Voltages*1

Range (V)	15	75	350	1500
Max Continuous Peak Current (A)	10	2	0.5	0.1
Peak Pulse Current (A)	≥20	≥4	≥1	≥0.2

*1 *Peak open-circuit voltages within +35% and −5% of indicated range.*

Series Resistance—From 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak Power Limit Setting: 0.1, 0.5, 2.2, 10, 50, and 220 W.
Safety Interlock—Protects operator from dangerous voltages.

STEP GENERATOR

Current Mode—Step/Offset Amplitude Range: 5 nA/step (with X0.1 Mult) to 200 mA/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 amplitude setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 10 V. Maximum Opposing Offset Current: X10 amplitude setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 to 3 V.
Voltage Mode—Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): X20 amplitude-switch setting, 40 V maximum. Maximum Current (Steps and Aiding Offset): At least 2 A at 10 V, derating to 10 mA at 40 V. Short-Circuit Current Limiting: 20, 100, 500 mA +100%, −0%; 2 A +50%, −0%. Maximum Opposing Offset Voltage: X10 amplitude setting. Maximum Opposing Current: Limited between 5 and 20 mA.

Accuracy—Incremental: Within 5%, between steps, within 10% with X1.0 Mult. Absolute: Within 2% of total output including offset, or 1% of amplitude setting, whichever is greater. Offset Multiplier: Continuously variable from 0 to X10 the amplitude setting, either aiding or opposing the step polarity.
Step Rates—Selectable at X1, X2, or X4 line frequency.
Pulsed Steps—≈80 or 300 μs width.
Step/Offset Polarity—Same as Collector-Supply polarity and positive in ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.
Step Family—Repetitive or single family.
Number of Steps—Selectable from 1 to 10.
Vertical-Deflection Factor—Collector Current: 1 μA to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter Current: 1 nA to 2 mA/div, 20 steps in 1-2-5 sequence. Step Generator: 1 step/div.
Horizontal-Deflection Factor—Collector Volts: 50 mV to 200 V/div, 12 steps (5 mV/div with X10 magnification). Base Volts: 50 mV to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step Generator: 1 step/div.

POWER REQUIREMENTS

Voltage Ranges—90 to 136 V ac or 180 to 272 V ac (six positions).
Line Frequency—48 to 66 Hz.
Maximum Power Consumption (Including DUT Power)—305 W. Standby Power: ≈60 W.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: +10 to +40°C. Nonoperating: −40 to +65°C.
Altitude—Operating: To 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 to 50 to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.
Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.
Safety—CSA Certified (CSA 556 B).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	299	11.8
Height	381	15.0
Depth	591	23.3
Weight ≈	**kg**	**lb**
Net	32.0	70.5
Shipping	48.5	107.0

STANDARD TEST FIXTURE (650-0459-01)

A plug-in fixture with two sets of five-pin test terminals, the Emitter Grounded or Base Grounded switch, Left-Off-Right switch, Step Gen Output, Ext Base or Emitter input, and the Safety Shield. The test terminals accept either the six-pin universal adapters, three-pin adapters, or the high-power transistor adapters with Kelvin contacts.

Position Controls—Fixed 5-div increments within 0.1 div. Continuous fine control over 5 div or less.
Display Offset—21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 Magnifier.

CRT

CRT—165-mm (6.5 in.) rectangular with 10×10-cm divisions (12 cm usable horizontal) parallax-free, illuminated graticule, GH (P31) phosphor standard. Accelerating potential is 4.0 kV.
Readout—The readouts, adjacent to CRT, are digital indicators of the following parameters: Per Vert Div from 1 nA to 2 A/div; per Horiz Div from 5 mV to 200 V/div; Per Step from 5 nA to 2 A/step, 5 mV to 2 V/step; A (Beta) or gm, per Div from 1 μ to 500 k calculated from Current/Div, X10 Mag, Step Amplitude, and X0.1 Mult.

The 176 Pulsed-High-Current Fixture provides the 576 Curve Tracer with pulsed-collector operation to 200 A peak and pulsed-base steps to 20 A peak. When selected, the step offset is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small-signal transistors can be tested under pulsed-collector-breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the step generator in regard to width and repetition rate.

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width—300 or 80 μs determined by 576.
Repetition Rate—Power-line frequency.
Polarity—± determined by 576 polarity control.
Amplitude—Ranges: 15, 75, 350 V nominal, controlled by Max Peak Volts switch on 576. Current (minimum available at low line into shorted load): 15-V range, 200 A; 75-V range, 40 A; 350-V range, 8 A.
Maximum Peak Watts—Three illuminated pushbuttons select 10, 100, or 1000 W maximum peak power.

STEP GENERATOR

Current Ranges (X10 Step Selected)—Step/Offset Amplitude Range: 100 mA to 2 A, 5 steps, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): 200×576 Amplitude setting or 20 A, whichever is less. Maximum Voltage (Steps and Aiding Offset): At least 5 V up to 10 A and 2 V up to 20 A.
Accuracy (Current Steps Including Offset)—Incremental: Within 5% between any two steps; within 10% with X0.1 Step Mult. Absolute: Within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.
576 Offset Multiplier—0 to 100×576 Amplitude switch setting.
Step Rate—Power-line frequency.
Pulsed Steps—300 or 80 μs wide.
Step/Offset Polarity—Same as Collector-Supply polarity. Polarity can be independently inverted with Step/Offset Polarity control.

VERTICAL AMPLIFIER

Deflection Factor (X10 Vert Selected)—1 to 20 A/div, 5 steps in a 1-2-5 sequence.

ORDERING INFORMATION

576 Curve Tracer
With Standard Test Fixture **$15,500**
Includes: Standard test fixture (650-0459-01); transistor adapter A1007; FET adapter A1009; TO-3/TO-66 adapter A1003 Opt. 01; axial lead diode adapter A1005; stud diode adapter (013-0110-00); Kelvin sensors for large and small plastic transistors A1002 Opt. 01; safety shield (337-1194-02); power cord (161-0066-00); instruction manual (070-0905-01).

OPTION

Option 01—Deletes the auto scale-factor readout module but maintains provisions for insertion of the module (020-0031-00) at any time. **−$975**

CONVERSION KIT

Auto Scale-Factor Readout Module—
Order 020-0031-00 **$1,735**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Test Set-Up Chart—Package of 250.
Order 070-0970-01 **$10**
Test Fixture—(176) **$6,190**
Socket Adapters—In this section.
Camera—C-59A and adapter.
See Accessories section. **$1,375**
Cart—K217. **$510**

ORDERING INFORMATION

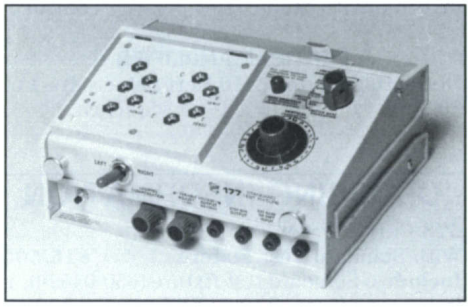
176 Pulsed-High-Current Fixture **$6,190**
Includes: TO36 adaptor (013-0112-00); stud diode adaptor (013-0110-00); safety shield (337-1194-02); instruction manual (070-1073-00).

577/177

- **Test Two-Terminal and Three-Terminal Discrete Semiconductors**
- **Storage Capability (Model D1)**
- **Power Capability Up to 100 Watts**

TYPICAL APPLICATIONS

Incoming Inspection
Semiconductor R & D



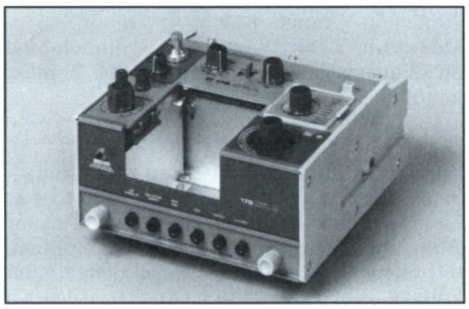
177 Standard Test Fixture.

The 577 Curve-Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear-IC Test Fixture. The major features that separate the 577 from the 576 are a storage CRT (optional) and the emphasis on low-current measurements with the 577.

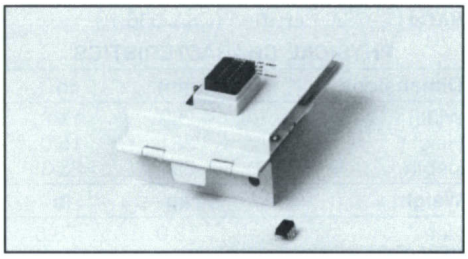
The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high-current pulsed testing or during very low-current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op-amp testing because the open-loop, 3-dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear-IC Test Fixture.

In the 577/177 Curve-Tracer System, several features facilitate low-current measurements. They include: small-current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector-supply lead (which permits measurements on three-terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal-deflection factor), and a display filter (which reduces vertical-deflection noise).

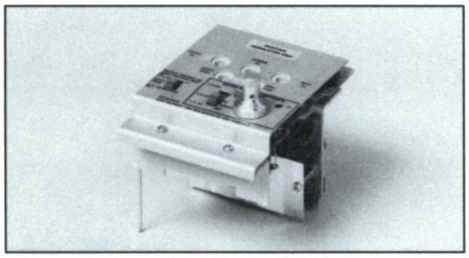
Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available; 10 A continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.



178 Linear-IC Test Fixture.



Standard Op-Amp Card for 178 Test Fixture.



Three-Terminal Regulator Card for 178 Test Fixture.

Other innovations in the 577/177 Curve Tracer are an emitter-base-breakdown position on the lead-selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

A safety interlock protects the operator from dangerous voltages. For collector voltages greater than 15 V, a plastic protective safety shield must be in place over the test terminals and its lid closed before collector voltage can be applied.

CHARACTERISTICS

All characteristics are for the 577 Curve-Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Modes/Polarity—Norm: AC (at line frequency); positive or negative full-wave rectified ac. DC: Positive or negative dc.

Voltage*1

Range (V)	6.5	25	100	400	1600
Max Continuous Peak Current (A)	10	2.5	0.6	0.15	0.04
Peak Pulse Current (A)	20	5	1.25	0.30	0.08

*1 *Peak open-circuit voltages within +35% and −5% of indicated range.*

Series Resistance—From 0.12 Ω to 8 MΩ in 14 steps, all within 15%, ±0.1 Ω. Peak Power Limit Setting: 100, 30, 9, 2.3, 0.6, and 0.15 W.

Safety Interlock—Protects operator from dangerous voltages.

STEP GENERATOR

Current Mode—Step/Offset Amplitude Range: 5 nA/step (with X0.1 Mult) to 200 mA/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 amplitude setting, except X10 (2A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 7 V. Maximum Opposing Offset Current: X10 amplitude setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 to 5 V.

Voltage Mode—Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): 20 times amplitude-switch setting. Maximum Current: At least 100 mA at 0 V. Short-Circuit Current Limiting: Not more than 200 mA. Maximum Opposing Offset Voltage: X10 amplitude-switch setting. Maximum Opposing Current: Limited between 10 and 20 mA (derating to 0 mA at 20 V).

Accuracy—Incremental: Within 2% between steps. Absolute: Within 3% of total output or amplitude setting, whichever is greater. Within 4% with X.01 mult. Offset Multiplier: Continuously variable from 0 to X10 the amplitude setting, either aiding or opposing the step polarity.

Step Rates—Selectable at X1, X2, or X4 line frequency.

Pulsed Steps—≈300 μs width.

Step/Offset Polarity—Same as Collector-Supply polarity and positive in the ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

Step Family—Repetitive or single family.

Number of Steps—Selectable from 1 to 10 full-amplitude steps. Selectable up to ≈95 steps when using Step X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies*1

Display Mode	Normal (unmagnified)	Magnified
Norm and DC Modes		
Vertical Collector Current	3% ±1 nA	4% ±1 nA
Horizontal Collector Volts	3%	4%
Horizontal Base Volts	3%	4%
Step-Generator Mode		
Horizontal Mode	4%	5%

*1 *As a percentage of highest on-screen value.*

Vertical-Deflection Factor—Collector Current: 2 nA to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA to 0.2 A/div with X10 magnification).

Horizontal-Deflection Factor—Collector Volts: 50 mV to 200 V/div, 12 steps in 1-2-5 sequence (5 mV to 20 V/div with X10 magnification). Base Volts: −50 mV to 2 V/div, 6 steps in 1-2-5 sequence (5 mV to 0.2 V/div with X10 magnification). Step Generator: 1 step/div (0.1 step/div with X10 magnification).

Displayed Noise

Range (V)	6.5	25	100	400	1600
Vert Collector (nA)	0.5	2.5	8	20	50
Vert Emitter (nA)	0.5	2.5	8	20	50
Horiz Base (mV)	5	5	5	5	5
Horiz Collector (mV)	5	5	—	—	—

Automatic Scale-Factor Readout—Change in deflection factor is indicated by lights behind the knob skirt when using X10 Mag.

Automatic Positioning—Trace (or spot) is automatically positioned when Collector-Supply polarity is changed when using the 177.

Display Invert—Single control inverts display and repositions trace.

Display Filter—Selectable low-pass filter reduces vertical noise for easier high-sensitivity measurements.

CRT

CRT—Rectangular 165 mm (6.5 in.) with an 8×10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to GJ (P1). The D2 display unit has a nonstorage CRT with GH (P31) phosphor standard. Accelerating potential is 3.5 kV.

Beam Finder—Compresses off-screen trace to within graticule area.

POWER REQUIREMENTS

Line-Voltage Ranges (±10%)—100, 110, 120 or 200, 220, 240 V ac.

Line Frequency—50 to 60 Hz.

Power—155 W max at 110 V ac, 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature—Operating: +10 to +40°C. Nonoperating: −40 to +65°C.

Altitude—Operating: To 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in.) p-p displacement 10 to 50 to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.

Safety—CSA certified (CSA 556 B).

PHYSICAL CHARACTERISTICS

	577		177	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	224	8.8	201	7.9
Height	503	19.8	102	4.0
Depth	584	23.0	152	6.0
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	18.1	40.0	1.1	2.5
Shipping	22.7	50.0	2.7	6.0

When the 577 and 177 are ordered together, their combined shipping weight is ≈24 kg or ≈53 lb (domestic).

177 Standard Test Fixture

CHARACTERISTICS

Device-Lead Selection—Switch provides six different lead configurations. Three positions for Emitter-Grounded measurements provide Step Gen, Open (or Ext), and Short base-terminal connections. Two positions for Base-Grounded measurements provide Step Gen and Open (or Ext) emitter-terminal connections. One position provides for Emitter-Base-Breakdown or leakage measurements up to 25 V.

Left-Right Switch—Selects left or right test connections. Off in center position. Test connection area accepts all Tektronix Curve Tracer adapters and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation—Reduces display loops due to test-adapter capacitance and some device capacitance.

Variable-Voltage Supply—Continuously variable bias supply from −12 to +12 V. Source resistance is 10 kΩ or less.

ORDERING INFORMATION

577/D1 Storage Curve-Tracer Mainframe (Without Test Fixture) **$7,255**

577/D2 Nonstorage Curve-Tracer Mainframe (Without Test Fixture) **$6,270**

OPTION

Option 10—10×10-cm graticule. **+$95**

TEST FIXTURES

177 Standard **$1,495**

Includes: Transistor adapter for most bipolar transistors and some MOS FETs A1007; axial lead diode adapter with Kelvin sensing terminals A1005; safety shield for test connection area (337-1194-02); instruction manual (070-1436-00).

178 Linear IC (See this page.) **$3,735**

OPTIONAL ACCESSORIES

Test Set-Up Chart—Package of 250. Order 070-1639-00 **$7.50**

Device Adapter Sockets—See socket adapters in this section.

CRT Implosion Shield—Clear. For 577D1. Order 337-1440-00. **$3.75**

Camera—C-5C. See Accessories section. **$495**

Cart—K213. See Accessories section. **$625**

178

- **Tests Single, Dual, or Quad: Operational Amplifiers, Comparators, Differential Amplifiers, Regulators, and More**

Since linear ICs are typically tested under very low-current conditions, the 577/178 Curve-Tracer System is ideally suited to the task. The 178 Linear-IC Test Fixture provides the necessary and accurate low-current-measurement capability. Test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low-current, dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 mainframe, 178 Linear-IC Test Fixture, appropriate test cards (choose from three op-amp cards and two regulator cards), and the proper socket adapter that interfaces the system to the device-under-test.

Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op-amp cards and regulator cards. Op-amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

OP-AMP CARDS

The Standard Op-Amp Card is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, CMRR, gain, positive and negative PSRR, positive- and negative-supply current, and collector-supply current.

The Hardwire Card is designed for applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device-under-test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The Multiple-Op-Amp Card allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op-amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op-Amp Card.

Socket Adapters for Op-Amp Cards

The device-under-test socket on the Standard and Multiple Op-Amp Cards accepts several types of socket adapters using the Amphenol-Barnes Adapter System. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on the next page.

REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation, and ripple regulation, and quiescent and common-terminal current.

Socket Adapters for Regulator Cards

Socket adapters for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adapters used on the standard curve tracer. (See next page.)

CHARACTERISTICS

VERTICAL AMPLIFIER

Display Accuracies/Deflection Factor

Vertical*1	Normal	Magnified
Input Voltage or ΔInput Voltage	10 μV to 50 mV/div	1 μV to 5 mV/div
Accuracy*2	3%	4%
Input Current	50 pA to 0.2 mA/div	5 pA to 20 μA/div
Accuracy*2	3% ±50 pA	4% ±50 pA
Power-Supply Current	0.1 μA to 50 mA/div	10 nA to 5 mA/div
Accuracy*2	3% ±0.1 μA	4% ±0.1 μA
Collector-Supply Current	1 nA to 50 mA/div	0.1 nA to 5 mA/div
Accuracy*2	3% ±1 nA	4% ±1 nA

*1 *1-2-5 sequence.*
*2 *Percentage of highest on-screen values.*

POWER SUPPLIES

Voltage—Positive and negative supplies are adjustable from 0 to 30 V. Voltage of both supplies can be adjusted from a single calibrated control. Accuracy is within 2% ±100 mV. Negative supply can be independently adjusted by an uncalibrated control.
Current—At least 150 mA with adjustable current limiting.

SWEEP GENERATOR

Frequency Range—Adjustable from 0.01 Hz to 1 kHz. Sinusoidal signal controls output, common-mode input, or power-supply voltages of device-under-test.
Amplitude—Adjustable from 0 to 30 V peak.

SOURCE RESISTANCE

Resistor Values—Two each, 50 Ω, 10 kΩ, 20 kΩ, 50 kΩ, or external resistors. When vertical deflection factor is in 1 through 50 mV/div positions, add 550 Ω to all values.

LOAD RESISTANCE

Resistor Values—One each, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, 50 kΩ, or external resistors.

OTHER CHARACTERISTICS

DUT Supplies Disconnect—A single switch disconnects all power to the device-under-test; both plus and minus power supplies, collector supply, and step generator.
Function Switch—Selects vertical- and horizontal-deflection signals and connection of the test signal to the device-under-test.
Zero—Single pushbutton provides a zero reference to the CRT display and, in certain functions, nulls out offset voltage in order to measure Δinput V on the vertical-display axis.

COLLECTOR SUPPLY

The 25- and 100-V ranges of the collector supply (located on 577 mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for collector-supply performance.)

STEP GENERATOR

All of the capabilities of the step generator (located on 577 mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for step-generator performance.)

THREE-TERMINAL-REGULATOR TEST-CARD CHARACTERISTICS

DUT Input Supply—Input Voltage (Two Ranges): 0 to 30 V is within 2% ±200 mV of dial setting. 0 to 60 V is within 2.5% ±300 mV of dial setting. Regulation: Within 200 mV. Input Sweep Frequency: DC to 1 kHz. 300-μs Pulsed Current: 5 mA to 2 A.

Short Duration DC Current*1

Supply Voltage (V)	Current (mA)
0 to 10	700
10 to 20	350
20 to 40	350
40 to 60	120

*1 *One minute duration.*

DUT Current Load—5 mA to 2 A within ±3%, ±1.25 mA.
DUT Comparison Output DC Voltage Accuracy—0 to 10 V Range: Within 1% ±20 mV. 0 to 100 V Range: Within 1% ±150 mV.

PHYSICAL CHARACTERISTICS

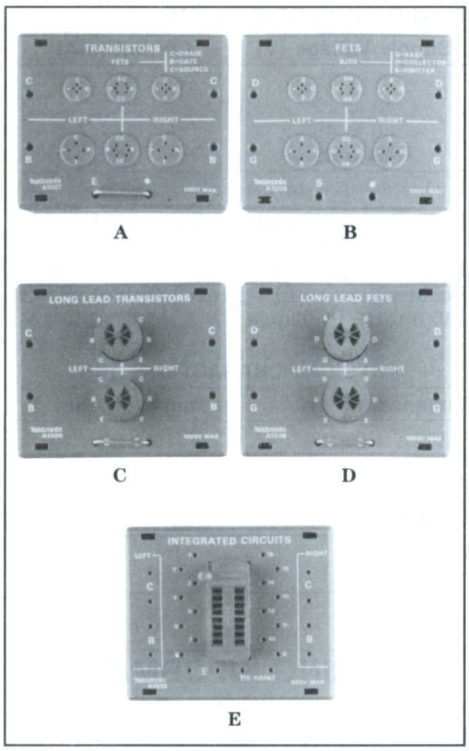
Dimensions	mm	in.
Width	201	7.9
Height	114	4.5
Depth	198	7.8
Weight ≈	**kg**	**lb**
Net	1.5	3.3
Shipping	3.6	8.0

ORDERING INFORMATION

178 Linear-IC Test Fixture **$3,735**
Includes: 16 DIP IC sockets (136-0442-00); standard Op Amp Card with cover and ten patch cords (013-0149-02); interchangeable nomenclature panel for function switch (333-1770-00); instruction manual (070-1977-00).

OPTIONAL ACCESSORIES

2 Inch Patch Cord—Package of 10. Order 012-0200-00. **$4.80**
Cards—
(Standard Op Amp) One included with 178. Order 013-0149-02 **$210**
(Hardwire) Order 013-0150-02 **$130**
(Multiple Op Amp) Order 013-0155-01 **$635**
(Positive Regulator) Order 013-0147-00 **$1,390**
(Negative Regulator) Order 013-0148-00 **$1,240**



DUAL WIDTH ADAPTERS

The following accessories fit the side-by-side terminals on test fixtures of the 370, 576, and 577/177 Curve Tracers.

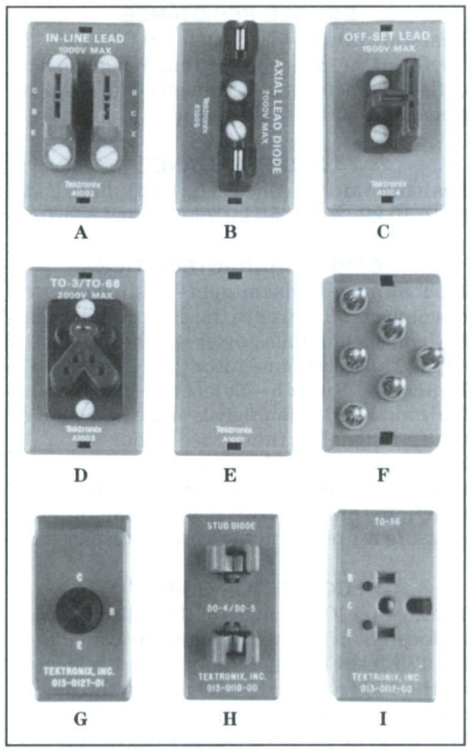
A. Transistor Adapter—Useful for most single and dual bipolar transistors and some MOS FETs. Order A1007 **$230**

B. FET Adapter—Useful for most single and dual FETs. Order A1009 **$230**

C. Long-Lead Transistor Adapter—Accepts dual or single transistors with untrimmed leads. Order A1006 **$200**

D. Long-Lead FET Adapter—Accepts dual or single FETs with untrimmed leads. Order A1008 **$255**

E. Integrated-Circuit Adapter—Allows connection to multipin device packages. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Includes one each lead for connecting auxiliary supply to tie points (196-3067-00); six each 4-inch test leads (012-0310-00). Order A1010 **$385**



KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 370, 371, 576/176, and 577/177 Curve Tracers.

Note: The standard version of adapters A1001 through A1004 have 6 terminals as shown in F above. These adapters are designed for use in the 370 and 371 only. The Option 01 version of adapters A1001 through A1004 have the base/gate sense terminal removed to permit their use in the 576 and 577 test fixtures. Adapter A1005 has 4 terminals and can be used in the 370, 371, 576, and 577.

A. In-line Adapter—Accepts large and small TO-220 transistors with in-line leads. The adapter will accept devices with approximate spacing between terminals of 0.06 in. up to 0.18 in. It is wired for both B-C-E and C-B-E terminal configurations. Order A1002 Option. 01 **$120**

B. Axial-Lead Diode Adapter—Order A1005 **$115**

C. Offset-Lead Adapter—Used for power transistors. Order A1004 Opt. 01 **$125**

D. TO-3/TO-66 Adapter—Used for power transistors. Order A1033 Opt. 01 **$125**

E. Blank Adapter—For mounting special sockets. Order A1001 Opt. 01 **$70**

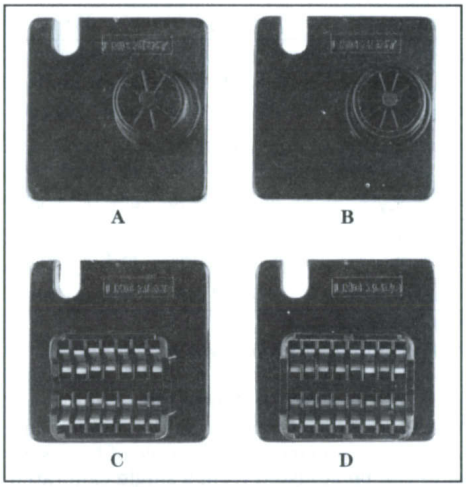
F. Example showing 6th pin for Base/Gate Kelvin Sensing

NOTE: Adapters G, H, I are not recommended for use with the 370 or 371, as they can remove the gold plating from the test fixture receptacles; however, they will physically fit.

G. Transistor Adapter—Accepts long- or short-lead transistors. Can be rewired to accommodate nonstandard configurations. Order 013-0127-01 **$90**

H. Stud Diode Adapter—Order 013-0110-00 **$105**

I. TO-36 Adapter—Order 013-0112-00 **$105**



MULTILEAD SOCKETS

These sockets are used with the 178 Test Fixture and IC adapter A1010.

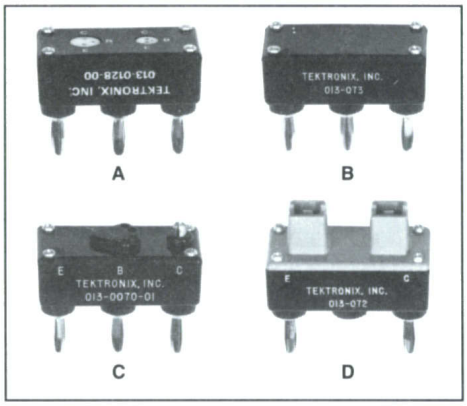
A. 8-Lead TO Package—Order 136-0444-00 **$55**

B. 10-Lead TO Package—Order 136-0441-00 **$60**

C. 14-Lead Dual In-Line Package—Order 136-0443-00 **$60**

D. 16-Lead Dual In-Line Package—Order 136-0442-00 **$55**

These four sockets are the most commonly required in curve-tracer applications. Additional socket configurations, including zero-insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.



3-PIN ADAPTERS

The 3-pin adapters may be used with any of the Tektronix curve-tracer products. They do not have Kelvin sensing contacts.

A. TO5 and TO18—Transistor Adapter. Order 013-0128-00 **$42**

B. Blank Adapter—For mounting special sockets. Order 013-0073-00 **$20**

C. TO3 or TO66—Transistor Adapter. Order 013-0070-01 **$55**

D. Diode Test Adapter—Holds axial-lead diodes. Order 013-0072-00 **$92**

5CT1N/7CT1N

- **Tests Semiconductor Devices to 0.5 Watts**
- **10-nA to 20-mA/Div Vertical-Deflection Factors**
- **0.5-V to 20-V/Div Horizontal-Deflection Factors**
- **Easy to Operate**

The 5CT1N and 7CT1N are oscilloscope plug-ins for displaying the characteristic curves of small-signal semiconductor devices to power levels up to 0.5 W. The 5CT1N is designed for use in any Tektronix 5000-Series oscilloscope and plugs into one of the vertical compartments (a 5000-Series amplifier or time base must be installed in the horizontal compartment). The 7CT1N is designed for use in any Tektronix 7000-Series oscilloscope and plugs into either a vertical or horizontal compartment (a 7000-Series amplifier or time base must be installed in the corresponding horizontal or vertical compartment).

CHARACTERISTICS

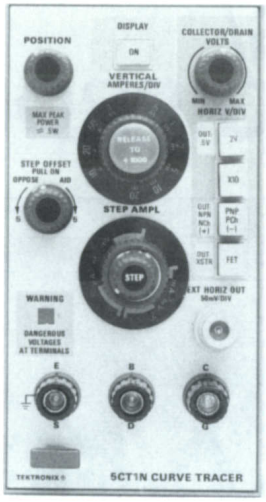
COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/div	0.5	2	5	20
Voltage Range (V)	0 to 7.5	0 to 30	0 to 75	0 to 300
Maximum Current (mA)	240	60	24	6

Maximum Open-Circuit Voltage—Within 20%. Maximum short-circuit current within 30%.
Series Resistance—Automatically selected with horizontal V/div switches. Peak Power: 0.5 W or less depending upon control settings.
High-Voltage Warning—When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

Transistor Mode—Step-Amplitude Range: 1 μA to 1 mA/step, 1 2-5 sequence. Maximum Current (Steps Plus Aiding Offset): X15 amplitude setting. Maximum Voltage (Steps Plus Aiding Offset): At least 13 V. Maximum Opposing Offset Current: At least X5 amplitude setting.
FET Mode—Step-Amplitude Range: 1 mV to 1 V/step, 1-2-5 sequence. Voltage Amplitude (Steps Plus Aiding Offset): X15 amplitude setting, 13 V maximum. Source Impedance: 1 kΩ ±1%.
Accuracy—Incremental: Within 3% between steps. Absolute: Within (3% + 0.3X amplitude setting).
Step Polarity—The step-generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.



5CT1N Curve Tracer

Number of Steps—Selectable in one-step increments between 0 and 10.
Offset—Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.
Vertical-Deflection Factors—10 nA to 20 μA/div with the 1000 control activated. 10 μA to 20 mA/div in the X1 mode.
Vertical-Display Accuracy—Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷1000 mode.
Horizontal-Deflection Factors—Selectable, 0.5, 2, 5, or 20 V.
Horizontal-Display Accuracy—(5CT1N) Within 5% plus the deflection-factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 5000-Series plug-ins) with a 50-mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 5000-Series oscilloscope mainframe.
Horizontal-Display Accuracy—(7CT1N) Within 5% plus the deflection-factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 7000-Series plug-ins) with a 100-mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 7000-Series oscilloscope mainframe.

ENVIRONMENTAL

Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration in each direction along each major axis. Total of six shocks.
Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.
Altitude—Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in.) p-p displacement 10 to 50 to 10 Hz in one-minute cycles. Held for three minutes at 50 Hz.

7CT1N Curve Tracer

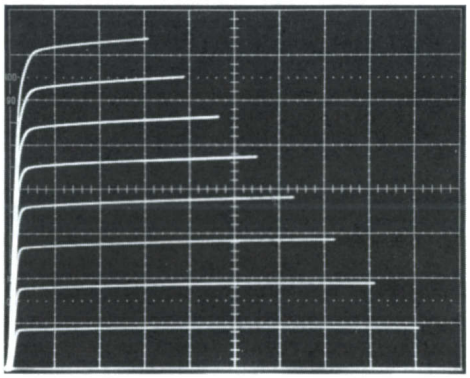
PHYSICAL CHARACTERISTICS

	5CT1N		7CT1N	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	66	2.6	71	2.8
Height	127	5.0	127	5.0
Depth	305	12.0	368	14.5
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	0.8	1.8	1.1	2.5
Shipping	1.8	4.0	2.7	6.0

ORDERING INFORMATION

5CT1N Curve Tracer **$1,125**
Includes: Test adapter with two sets of test terminals, one with TO5 basing and the other with TO18 basing (013-0128-00); instruction manual (070-1246-00).
7CT1N Curve Tracer **$1,870**
Includes: Same as 5CT1N but with instruction manual 070-1247-00.

See 3-pin adapters on preceding page.



2N3904 transistor characteristic generated by the 7CT1N. Control Settings are indicated on front panel of 7CT1N.
Vertical: 2 mA/div.
Horizontal: 0.5 V/div.
Base Current: 10 μA/step.

SIGNAL ROUTING/ DUT INTERFACING PRODUCTS

CONTENTS

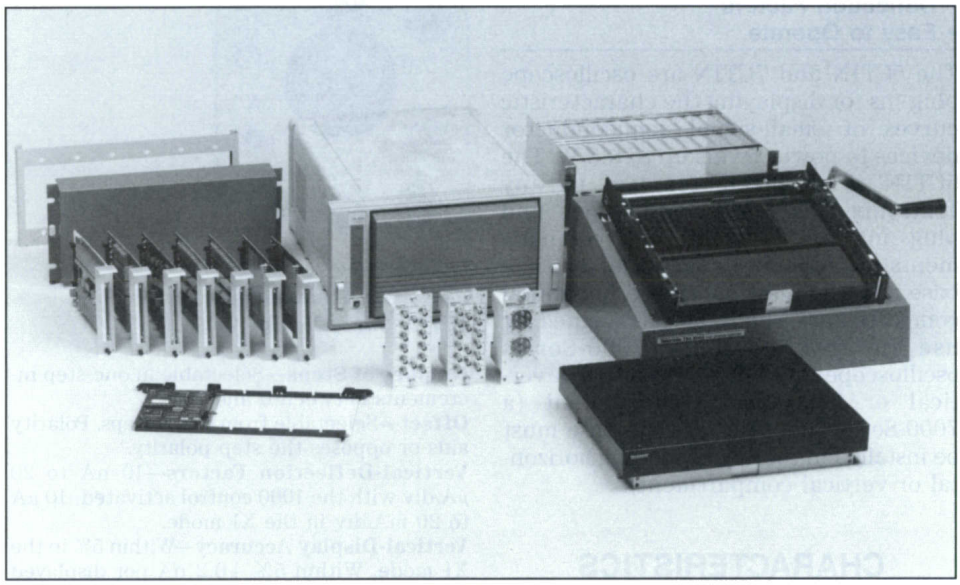
TSI 8150 Test-System Interface . . 421
NEW TSX 8140 Expansion Chassis 422
TSA 8140 Test System Adapter . . 423
Auxiliary Card Rack 423
Auxiliary High-Frequency Mounting Unit 423
TSS40 Scanner Control Assembly 424
NEW TSD42 Digital Interface 424

Scanner/Switch/Driver Cards
TSS41 Low-Level Scanner Card . . 425
TSS42 General-Purpose Scanner Card 425
TSS43 Power Switch Card 426
TSS48 Matrix Switch Card 426
High-Current Driver Card 426
60-mA Driver Card 426

Scanner Modules
TSS44 Coax Scanner Module . . . 427
TSS45 RF Scanner Module 427
TSS46 Microwave Scanner Module 427

MI 5010/MX 5010 Programmable Multifunction Interface and Extender 428

Programmable Function Cards
50M10 A/D Converter 429
50M20 D/A Converter 429
50M30 Digital Input/Output Card . 430
50M40 Relay Scanner Card 430
50M41 Low-Level Scanner 430
M41A1 Low-Level Amplifier for 50M41 431
M41A2 through M41A8 Thermocouple Amplifiers for 50M41 431
50M50 Memory Card 431
50M70 Development Card 432
SI 5010 Programmable Scanner . . 432
1360P/1360S Programmable Multiplexer 433



TSI 8150 (center rear) and family members.

COMPLETE SIGNAL-SWITCHING/DUT-INTERFACING SOLUTIONS IN A SINGLE PACKAGE

The Test-System Interface (TSI) family of off-the-shelf components can be easily and affordably configured to fit a majority of signal-switching and DUT-interfacing needs. The TSI 8150 Test-System Interface is the complete price/performance solution for your needs.

Systems can range in complexity from a mainframe and a single switching assembly, to DUT-interfacing adapters and multiple card/module switching configurations for up to 720 channels. DUT physical interfacing is accomplished with the Test System Adapter (TSA). Cards and modules are available for switching signals ranging from microvolts to 400 volts, from microamps to 10 amps, and from dc to 18 GHz.

Rackmounting is a standard feature as well as IEEE-488 bus operation. Along with this, you get conformity with Tek *Codes and Formats*, Tektronix' high-quality documentation and after-sales support, and a commitment to quality.

SYSTEM CONTROL/SIGNAL ROUTING IN A TM 5000 PACKAGE

A wide range of system-control and signal-routing capabilities are available in the popular TM 5000 line of fully programmable instruments. The MI 5010 Multifunction Interface and MX 5010 Multifunction Interface Extender can provide functions such as: D/A and A/D converters, 32-channel digital I/O, 16-channel relay scanner, 10-channel low-level scanner (with a choice of signal-conditioning modules), 16K memory, and a user-configurable development card. The MI 5010 and MX 5010 are also part of the MP 2901 Inspection Test Station package (see the Measurement Packages Section).

The SI 5010, another instrument from the TM 5000 line, offers fully programmable, 50-Ω scanning of high-frequency signals (to 350 MHz for four channels). The SI 5010 also has built-in intelligence that can free your GPIB controller for activities elsewhere on the bus. The MI 5010/MX 5010 and SI 5010 are UL Listed, as are all TM 5000 instruments.

For economical multiplexing of signals up to 250 MHz in a standalone package, the 1360P/1360S is the answer. This microprocessor-controlled combination can be operated locally or controlled over the GPIB, and offers a variety of switch configurations.

Tektronix offers the complete solution for your physical DUT-interfacing/signal-switching/multiplexing requirements.

TSI 8150

GPIB IEEE-488

The TSI 8150 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

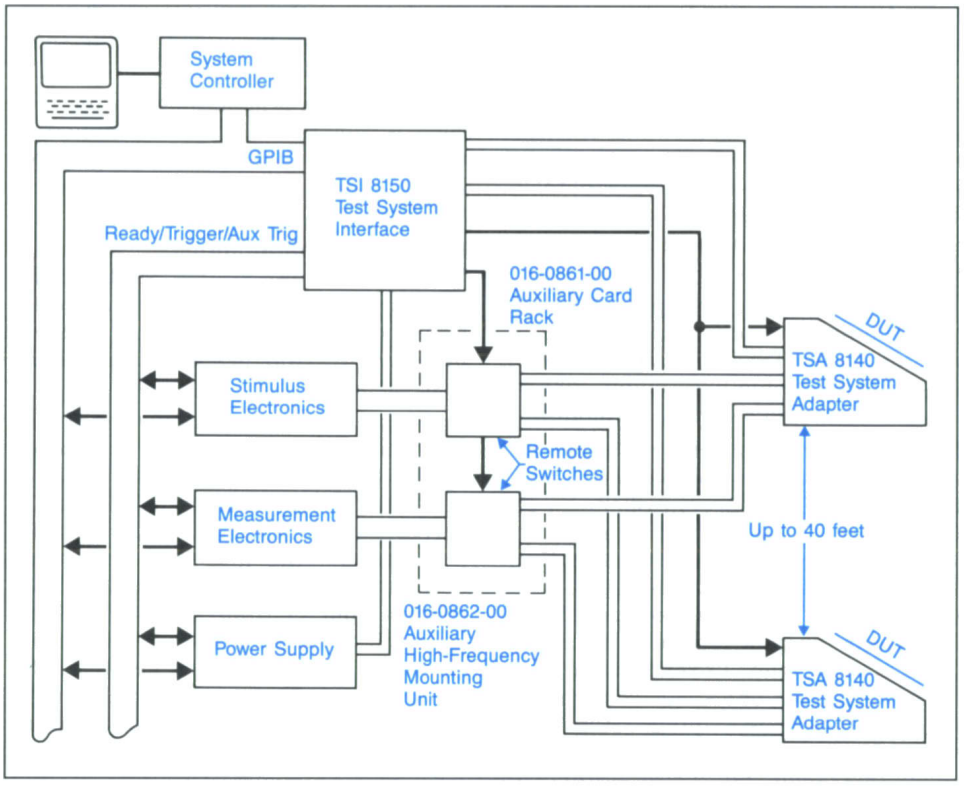
- **Complete Line of Scanner Cards and Modules**
- **Complete Line of Accessories for Switch-Mounting and DUT-Interfacing Requirements**
- **Flexible Mechanical Architecture Permits Signal Access From Front, Rear, or Both**
- **Low-Noise Linear Power Supply and Remote Switching (at the DUT) for Signal Integrity**
- **Intelligent Mainframe and Control Assemblies Free System Controller for Other Tasks**
- **Real-Time Sequencing Maximizes Throughput**

In applications where DUTs span a wide range of bandwidth, power, signal-routing, and physical-interfacing requirements, most test interfaces have had to be custom designed and built. In addition to being time consuming and expensive, these custom fabrications were difficult and costly to maintain, and documentation was a problem.

Now, Tektronix offers the solution! The TSI 8150 family of off-the-shelf components can be easily and affordably configured to fit a majority of signal switching and DUT interfacing needs. The documentation is clear and comprehensive, a Tektronix tradition.

Whatever your signal-routing needs, the TSI 8150 has the answer: digital or analog; front or rear signal access (or both); remote switching; signal levels from microvolts to 400 volts; currents from microamps to 10 amps; and frequency ranges to 18 GHz (with less than 0.5 dB insertion loss and VSWR better than 1.5:1). Two custom driver cards are available for routing specialty signals or for controlling devices such as actuators, solenoids, stepper motors, and robotics.

Physical interface to the DUT is provided by the TSA 8140 Test System Adapter. The TSA can be mounted horizontally, vertically, or in a system rack with optional rack slides. An extensive offering of interchangeable test adapters lets you test a wide variety of device types, such as hybrids, circuit boards, and components. Test adapters can be easily modified to accept various Zero Insertion Force (ZIF) sockets and adapters. An optional Test Head Receiver (021-0435-00) is Virginia Panel Corporation Series 3200 compatible, which opens the door to a large selection of vacuum bed-of-nails test adapters for circuit-board testing.



Scanner cards and modules can be mounted in the mainframe, in the auxiliary mounting units, or in the test-system adapter, up to 40 feet away from the mainframe. Mounting the assemblies in the test-system adapter puts the switching as close to the DUT as possible, helping the TSI 8150 to ensure signal integrity. Numerous other techniques are used to make sure your signals stay clean, such as individually shielded function cards and a low-noise linear power supply.

Each scanner card, or each two identical scanner modules, has a dedicated control card that provides real-time control for up to 32 switches in any closure pattern, with storage of up to 500 test sequences. Add programmable make-before-break (MBB) or break-before-make (BBM) for each switch, and you have unparalleled control over your switches.

Expandability is another of the TSI 8150's strong points. With a maximum configuration utilizing a TSX 8140 Expansion Chassis, optional second main interconnects in both the mainframe and expansion chassis, and 016-0861-00 Auxiliary Card Racks or 016-0862-00 Auxiliary Mounting Units, up to 720 channels can be scanned.

The Basic Building Block

The TSI 8150 mainframe is the basic building block of the Tektronix TSI 8150 Test-System Interface family. It is an intelligent and flexible interface mainframe that provides power, control, timing, and housing for TSI 8150-family scanner cards and modules.

A wide variety of scanner cards and modules are available: low-frequency cards; low- and high-voltage cards; power switches; and microwave switches. (Refer to the individual card and module specifications and ordering information sheets.)

The TSI 8150-family mechanical architecture provides flexible front or rear access to installed cards and modules.

With the TSI 8150 family, one test set-up can combine total physical interfacing with the complete switching solution offered by the TSI 8150 line of scanner cards and modules. The result is a test-system interface qualified for many automated test applications.

Test engineers will benefit from the flexibility and versatility of the TSI 8150 mainframe and other family members. The TSI 8150 family is especially well suited for complex test requirements and for applications requiring periodic test set-up changes. Examples of these applications include testing of components,

hybrids, circuit boards, sub-assemblies, and complete products.

In some test systems, the controllers don't lend themselves to real-time operation. For these systems, combining TSI 8150 mainframe local intelligence with its timing capability produces a powerful team. The TSI 8150 mainframe's handling of switch sequencing and timing frees the controller for other tasks.

The TSI 8150 mainframe provides scanner timing and control information through the TSS40 Scanner-Control Assembly. This plug-in assembly controls TSI-family scanner cards and modules.

Real-Time Execution, Higher Throughput

The TSI 8150 mainframe receives instructions from the system controller over the GPIB, storing up to 500 test steps on each TSS40 Scanner Control Assembly. Each TSS40, in turn, passes the instructions to the scanners (one card or up to two modules of the same type) that it controls. The system can then use external triggers, internal triggers, or a single command to increment each test-sequence step. Using stored settings and either a trigger or a single bus command, a test system can change the state of hundreds of switches at the same time.

TSI 8150-family control commands conform to the simple, English-like Tektronix *Standard Codes and Formats* guidelines. These commands are easy to remember and use. Each command performs a function, such as opening or closing a specific switch, opening or closing a combination of switches, or opening all switches. For example:

- The command 0CLOSE.F2 A3 . . A6 closes switches A3, A4, A5, and A6 on the second front scanner and opens all other contacts.
- The command OPENALL opens all switches—a useful software panic button. It can also serve as a "warm reset" without clearing sequence buffers.

Two independent programmable timers provide flexible control for sequencing and delay generation, thus offloading these tasks from the system controller.

The TSI 8150 also includes a 24-bit up/down totalizer. The timers and the totalizer can be tied to an extensive trigger system. This connection provides flexible real-time control of scanners. Unlike other scanning systems that have only one trigger, the TSI 8150 mainframe contains 10 general-purpose and three dedicated trigger lines.

Test-system engineers can program individual relays for Make-Before-Break or Break-Before-Make operation. The two capabilities can be mixed on the same card or module.

Signal integrity is maintained by features such as remote mounting of scanners to reduce noise induced in long cable lengths, and a low-noise linear power supply.

Variety of Configurations

With suitable options, the TSI 8150 mainframe can simplify test-system configuration by providing connections to the scanners from the front of the mainframe, the rear, or both.

In its standard configuration, the TSI 8150 mainframe holds up to six cards or seven modules or a combination of cards/modules. Scanner cards and modules are accessible from the rear of the unit. By repositioning the interface board, the user can make the cards and modules accessible from the front. Using an optional second interface board, the user can access some cards and modules from the front and rear. A cableway allows convenient routing of cables between the front and rear of the test system.

Remote mounting is available for a variety of configurations. To maximize signal integrity, the user can place scanner modules in the TSA 8140 Test-System Adapter, close to the DUT itself. The user can also rackmount scanner and switch cards in the 016-0861-00 Auxiliary Card Rack and modules in the 016-0862-00 Auxiliary High-Frequency Mounting Unit. These units can be placed anywhere in the test system up to 12 meters (40 feet) from the TSS40 Scanner-Control Assemblies.

CHARACTERISTICS

TOTALIZER

General—Programmable gate, preload, reset, and source select. Can send SRQ on underflow/overflow.
Maximum Count—16,777,215 (24 bits).
Minimum Pulse Width—250 ns.
Maximum Repetition Rate—1 kHz.

TIMER

General—Two independent pulse generators, source and destinations are trigger lines; programmable source, destination, period, width, delay, burst pulse count, and gate; can generate an SRQ at end of last pulse count.
Resolution—10 ms.
Delay Accuracy—0.01% +10, −0 ms.
Period, Width Accuracy—0.01% +100, −0 μs.
Minimum Period—20 ms.
Maximum Delay, Period, Width—655.35 s.
Maximum Burst Count—66535 or continuous.
Input/Output—TTL compatible.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	483	19.0
Height	264	10.4
Depth	641	25.3
Weight ≈	**kg**	**lb**
Net	23.9	52.5
Shipping	35.4	78.0

POWER REQUIREMENTS

Line-Voltage Ranges—100, 110, 120, 200, 220, or 240 V ±10%.
Line Frequency—48 to 66 Hz.
Maximum Power Consumption—525 W (567 V A).

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +50 °C. Nonoperating: −40 to +75 °C.

For ordering information, see page 428.

NEW TSX 8140

Expansion Chassis

- **Doubles TSI 8150 Channel Capacity**
- **Has Same High-Quality Power Supply as TSI 8150 Mainframe**
- **Same Options as the TSI Mainframe**

Double Channel Count without Doubling Cost

TSI 8150 users can now double their channel-scanning capacity, while retaining single-mainframe control. The **NEW** TSX 8140 Expansion Chassis uses the same main interconnect as the TSI 8150 Mainframe, and can accommodate the same number of scanners (6 cards or 7 modules). The options are also the same as for the mainframe; Option 01 for front access, Option 02 for both front and rear access.

Control for the TSX 8140 is provided by the TSI 8150 mainframe. One TSX 8140 can be connected to each TSI 8150. To ensure adequate power for a maximum number of channels, the TSX 8140 has its own built-in power supply; the same high-quality, low-noise linear supply used in the mainframe.

Using the TSX 8140, a switching system can be configured with as many as 720 channels, using 016-0861-00 Auxiliary Card Racks and TSS42 General-Purpose Scanners, or up to 576 Coax, RF, or Microwave channels using 016-0862-00 Auxiliary Mounting Units.

TSA 8140

Test System Adapter

- **Configurable Top Panel for Dedicated Applications**
- **Optional Test-Head Receiver, Allowing Easy Interfacing to a Wide Range of Devices Under Test**
- **Interchangeable Test Adapters Provide for Custom Interfacing (Hybrids, Components, etc.) plus Commercially Available Bed-of-Nails Test Heads**
- **Accepts the Entire TSI 8150 Family of Scanners to Maintain Signal Integrity by Minimizing Cable Lengths**
- **Rugged Steel Construction for Low-Frequency Noise Shielding**

Complete Link to Your DUT

The TSA 8140 Test-System Adapter provides system builders with the direct link between the device under test (DUT) and the test system.

One-of-a-kind DUT-interface designs are often expensive to build, inadequately documented, and difficult to service. When the original system builders change jobs, they take their design concepts with them. Another problem is that one-of-a-kind designs are difficult (or impossible) to adapt to changing test-system needs.

Using the TSA 8140's commercially available test heads cuts DUT adapter development time and materials costs.

The TSA 8140 ensures excellent signal integrity by allowing system builders to place switching and custom signal conditioning circuits very near the DUT. Steel construction shields tests circuits from low-frequency magnetic fields.

The removable top panel allows system builders to configure the TSA 8140 for a dedicated application.

The TSA 8140 can be mounted horizontally or vertically. In either configuration, rack slide rails can be added.

For visual inspection of hybrid integrated circuits with a microscope, or other situations where a level stand is needed, the TSA F02 converts the TSA 8140 work surface from its normal slant to a level attitude.

The TSA F10 Low-Frequency Quick Connect facilitates rapid connection from an 021-0435-00 Test-Head Receiver to TSS42 or TSS48 Scanner Cards, or to 021-0417-00 and 021-0418-00 Relay Driver cards. The TSA F11 High-Frequency Quick Connect and 021-0441-00 Extended Frame Interchangeable Test Adapter provide the same convenience for TSS44 and TSS45 Scanner Modules.

A Member of the TSI Family

The TSA 8140 is a fully-compatible member of the Tektronix test-system interface family. The TSA 8140 accepts the same series of scanner cards and modules that can be mounted in the TSI 8150 Test-System Interface mainframe. The modules mounted in the TSA 8140 are controlled by TSS40 Scanner-Control Assemblies in the TSI 8150 mainframe or TSX 8140 Expansion Chassis.

For test configuration changes, an optional test-head receiver can be added to make the TSA 8140 compatible with Interchangeable Test Adapters (ITA). This receiver is also compatible with Virginia Panel Corporation's 3200 Series bed-of-nails test heads.

Optional test-head adapters and a rack-mounting kit are also available.

PHYSICAL CHARACTERISTICS

	TSA 8140	
Dimensions	**mm**	**in.**
Width		
Total	558	22.0
Usable Area	482	19.0
Height		
Front	115	4.5
Back	222	8.8
Depth	470	18.5
Weight ≈	**kg**	**lb**
Net	11.8	26.0
Shipping	14.0	31.0

PHYSICAL CHARACTERISTICS

	Test Head Receiver		Full Size Interchangeable Test Adapter		Half Size Interchangeable Test Adapter	
Dimensions	**mm**	**in.**	**mm*1**	**in.**	**mm*1**	**in.**
Width	597	23.5	450	17.7	450	17.7
Height	121	4.8	376	14.8	182	7.2
Depth	419	16.5	46*2	1.8	46*2	1.8

*1 *Usable area, top panel.*
*2 *Inside depth.*

For ordering information, see page 428.

AUXILIARY CARD RACK, AUXILIARY HIGH-FREQUENCY MOUNTING UNIT

- **Fit into Standard 19-Inch Racks for Convenient Placement**
- **Accept Up to 12 Scanner Cards (Card Racks) or 6 Scanner Modules (HF Mounting Units)**
- **Can be Mounted in a Vertically or Horizontally Configured TSA 8140 Test-System Adapter for Greater Flexibility**

Remote Location

In large ATE systems, system builders must sometimes distribute switching functions: some switches near the DUT, some near the stimulus instruments, and some near the measurement instruments. The Auxiliary Card Rack (016-0861-00) and the Auxiliary High-Frequency Mounting Unit (016-0862-00) solve this problem by providing the hardware that system builders need to physically mount scanners in remote locations. The TSI 8150 mainframe provides the power and control for remotely mounted scanner cards and modules.

The 016-0861-00 and 016-0862-00 can be placed in standard 19-inch racks. They can be attached to either the front or back of a standard rack cabinet.

The 016-0861-00 accepts all TSI 8150-family scanner cards and can be placed in the back of a horizontally mounted TSA 8140 Test System Adapter. Two can be placed in the back of a vertically mounted TSA 8140.

The 016-0862-00 accepts all TSI 8150-family scanner modules. One 016-0862-00 can be mounted inside the TSA 8140.

PHYSICAL CHARACTERISTICS

	016-0861-00 Auxiliary Card Rack		016-0862-00 Auxiliary High-Frequency Mounting Unit	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	483	19.0	483	19.0
Height	178	7.0	222	8.8
Depth	267	10.5	86	3.4
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	4.8	10.5	2.3	5.0
Shipping	5.5	12.0	2.7	6.0

For ordering information, see page 428.

TSS40

Scanner-Control Assembly

- **Real-Time Control of Up to 32 Switches for a Variety of Operations**
- **Storage of Up to 500 Test Steps for Higher System Throughput**
- **Programmable Trigger Sources for Flexible System Timing Coordination**
- **Switch Programming for Make-Before-Break or Break-Before-Make Switch Control**
- **Low-Cost 32-Bit Output and 5-Bit Input Interface**

Intelligent Control of Switches

The TSS40 Scanner-Control Assembly simplifies the system builder's task of controlling switches. In the Tektronix TSI 8150 family of scanners, each TSS40 controls one scanner card or up to two modules of the same type.

Switch control can be immediate or stored by use of either scan or sequence mode. In the immediate mode, commands from the host GPIB controller directly program the switches. In the stored mode, the switches can be scanned one relay at a time or a sequence of up to 500 steps can be preprogrammed. With this buffer, the sequence can open or close more than one switch with each step.

In either storage mode, a single command or one of 12 hardware triggers can increment the test sequence. The *output latch* provides a TTL latched output to drive the scanners. In the immediate or stored modes, TSI 8150 mainframe hardware synchronizes all switch state changes at each step. A single command can change the state of up to 720 switches.

The *control section* performs timing functions, senses the scanner type that the TSS40 is controlling, and provides programmable make-before-break or break-before-make control. The *trigger-line* select block is a programmable matrix that selects the lines that will trigger the TSS40.

Though designed to control scanners in the TSI 8150 family, the TSS40 can be used in a variety of special applications. In standalone applications, the TSS40 provides a TTL-compatible, 32-bit digital-output and a 5-bit digital-input interface. Typical applications are 32-bit pattern generation and reading an encoded word on interchangeable test heads (to assure installation of the proper test head).

Ready and Sequence-Done Outputs

The TSS40 includes two program-maskable output signals. Both are wire-ORed with the outputs of other scanner control assemblies.

The *ready* line signals a change in the switch pattern and then starts a timer preset for the switch closure and bounce time. After the preset time has passed, the Ready line signals the establishment of a new path. The *sequence-done* line signals completion of the last pattern in the switch storage buffer.

Configuration Check

At power-up, the TSS40 reads a relay code from the scanner card or module(s) that it controls. From this code, the TSS40 checks an internal table to determine the switch settling time and card configuration. When driving custom relays, the user can program the TSS40 with the switch settling time.

CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	35	1.4
Height	177	7.0
Depth	442	17.4
Weight ≈	**kg**	**lb**
Net	0.5	1.1
Shipping	1.0	2.2

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +50 °C. Nonoperating: −40 to +75 °C.

POWER REQUIREMENTS

The TSI 8150 mainframe or the TSX 8140 Expansion Chassis provides power to the TSS40.

For ordering information, see page 428.

NEW TSD42

Digital Interface

- **Low-Cost Digital Input/Output**
- **12 WPS Input/1K WPS Output**
- **Input and Output Latches**
- **All Signal Lines Protected**

General-Purpose, 32-Bit Digital Interface

The **NEW** TSD42 can be used to interface other TSI 8150 system components to the DUT. The card provides 32 parallel non-isolated TTL input lines and 32 parallel nonisolated output lines. All signal lines have transient-protection networks to prevent card damage when operated in adverse environments.

The 32-bit output port of a TSS40 Scanner-Control Assembly provides the output data, in either immediate mode or from pre-stored patterns in the 500-step scanner-sequence buffer. The input word is multiplexed and read through the TSS40's "relay type" input.

Control for the TSD42 is provided by a TSS40 mounted in a TSI 8150 Mainframe or TSX 8140 Expansion Chassis. The TSD42 can be mounted on the TSS40, or externally connected by a ribbon cable up to 12-meters long.

TSI Family Scanner/Switch Cards

The TSI 8150 family of scanner cards are controlled by a TSS40 Scanner-Control Assembly mounted in a TSI 8150 Test-System Interface mainframe. Each card can be mounted in a TSI 8150 mainframe or mounted outside and connected to the TSI 8150 mainframe with a mass terminated ribbon cable, up to 12-meters (40 ft) long.

PHYSICAL CHARACTERISTICS

	TSS41		TSS42/ TSS43/TSS48	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	35	1.4	35	1.4
Height	178	7.0	178	7.0
Depth	308	12.1	308	12.1
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	0.7	1.5	0.5	1.1
Shipping	0.9	2.0	0.7	1.5

TSS41

Low-Level Scanner Card

- **One 1 × 20 or Two 1 × 10 Switch Trees**
- **Multiplexes Signals With Differential Thermal Offset Down to 40 μV (1 μV With Option 01)**
- **Offers Fast Settling Time for High Throughput**
- **Switches High, Low, and Guard**

A Selection of Switch Trees

The TSS41 Low-Level Scanner Card answers the system builder's need for multiplexing low-level signals. The differential thermal EMF (electromotive force) is ≤40 μV (1 μV with Option 01). In its standard configuration, the TSS41 offers two 1 × 10 switch trees. Moving a jumper creates a 1 × 20 tree. An additional tree-switch relay prepares the TSS41 for use in larger multiplexed systems by reducing parasitic capacitance when no channel in the 1 × 20 branch is selected.

The TSS41's ability to simultaneously switch two lines per channel enables the user to drive balanced inputs to DUTs. The guard line isolates capacitance around the signal channels and thereby improves bandwidth.

The standard TSS41 is well suited for applications as diverse as checking balanced transmission lines in audio testing and making transducer measurements in mechanical stress testing. The optional 1 μV differential thermal offset makes the TSS41 especially useful for many transducer measurements and most differential-signal test set-ups designed to eliminate common-mode problems.

TSI 8150-FAMILY SCANNER-CARD SELECTION GUIDE

Features	TSS41	TSS42	TSS43	TSS48
Thermal Offset	Std: <40 μV differential (<80 μV with tree switch); Opt 01: <1 μV (<2 μV with tree switch)	<100 μV	<100 μV	<100 μV
Maximum Switched Current	500 mA dc or peak ac	1.0 A dc or peak ac	10 A dc; 60 A surge for 2 ms	1.0 A, dc or peak ac
Maximum Carry Current	1.0 A	2.0 A	10 A	2.0 A (through screw terminals) 1.0 A (through square pin header)
Maximum Switched Voltage	250 V dc or peak ac 175 V RMS	400 V dc or peak ac (250 V Opt 01)	150 V dc 250 V RMS	400 V dc or peak ac (250 V Opt 01)
Maximum Switched Power	10 W	50 V A	2000 V A	50 W
Dielectric Standoff	300 V RMS, 400 V dc/peak ac	300 V RMS, 400 V dc/peak ac	300 V ac or 400 V dc	300 V RMS, 400 V dc/peak ac
Settling Time	4 ms	4 ms	51 ms	4 ms
Switch Life	10^8 @ signal level 10^6 @ rated load	10^9 @ signal level 10^7 @ rated load 10^8 @ signal level*1 10^6 @ rated load*1	3×10^7 mechanical 10^5 @ rated load	10^9 @ signal level 10^7 @ rated load 10^8 @ signal level*1 10^6 @ rated load*1
Switch Closures	20 3PST (High, low, guard)	30 SPST	10 SPDT	30 SPST
Channel Resistance	<2 Ω (each wire)	<150 mΩ <250 mΩ*1	<150 mΩ	<150 mΩ <250 mΩ*1
Power Requirements	24 V dc supplied from TSI 8150 mainframe or external source			
Environmental	Operating: 0 to +50°C; Nonoperating: −40 to +75°C			

*1 *Option 01.*

Board layout optimizes matching of parasitic capacitances of high and low signal paths to provide well balanced quality routing for critical signals.

TSS42

General-Purpose Scanner Card

- **30 Cost-Effective Channels for Configuration Flexibility**
- **Bounceless Mercury-Wetted Contacts for Long Switch Life**
- **Consistent Channel Resistance (±20 mΩ Typical) Over Switch Life for Greater Test Reliability**
- **Dry-Reed Version (Option 01)**

A Selection of Switch Trees

The TSS42 General-Purpose Scanner Card is a highly configurable, long-life switch assembly. It performs the many routine but essential multiplexing chores that complex test systems require. This versatile card arranges the channels in one group of 1 × 8, four groups of 1 × 4, and three groups of 1 × 2. Each channel is a single wire.

The TSS42 uses long-life mercury-wetted switches, minimizing system down time for switch replacement.

Printed circuit pads near the switches allow users to attach snubber networks for switching inductive loads.

The TSS42's many special features make it suited to a variety of applications. The long life, bounceless operation, consistent channel resistance over switch life and configuration flexibility qualify the TSS42 for many demanding manufacturing ATE test set-ups.

Multiple channels permit such uses as functional board testing. Other special uses include: audio switching; low-current power-supply switching into the DUT; bias-voltage control; and operations such as component testing that require high-repetition, long-life operations.

For users concerned about operating in mercury-prohibited environments or about mechanical positioning, Option 01 offers dry-reed switches in the same switch configuration.

For ordering information, see page 428.

TSS43 Power-Switch Card

- **10 Independent Power Channels for Primary and Secondary Power Switching**
- **Transient Suppressors for Switch Protection With Inductive Loads**
- **Switches DC Through 400 Hz for Applying Power to a DUT**
- **High-Power Switch Applications (250 V, 10 A, 2000 V A)**
- **Useful for System Power-Up Sequencing**

A Versatile Power-Switch Card

The TSS43 Power-Switch Card provides 10 independent switch lines designed to allow the user to switch primary or secondary supplies to the DUT.

Each channel consists of one normally open (NO) and one normally closed (NC) contact. Transient suppressors are wired between each NO and common and each NC and common. These suppressors protect the contacts when the card switches inductive loads.

The TSS43 can switch up to 10 A or 250 V (RMS), and is useful for switching power to the DUT. The most common use is dc or 60 Hz, but similar applications exist in 400-Hz avionic set-ups.

A special use is switching miscellaneous units such as device handlers, solenoids, and other line-operated fixturing actuators. The TSS43 has a 60-A inrush surge rating, enabling it to switch loads such as a one-quarter horsepower 120 V ac motor.

For ordering information, see page 428.

TSS48 Matrix Switch Card

- **30 Switches, in Five Rows by Six Columns, for Matrix Configuration Flexibility**
- **Bounceless Mercury-Wetted Switches for Long Switch Life**
- **Consistent Channel Resistance (±20 mΩ Typical) Over Switch Life for High Repeatability**
- **Dry-Reed Version (Option 01)**

A Versatile Matrix Switch Card

The TSS48 Matrix Switch Card is designed to route a variety of signals. The switch matrix contains five rows by six columns. Each crosspoint is a single wire.

The switches are long-life mercury-wetted relays. These relays minimize system down time for switch replacement.

Each switch trace on the printed circuit board includes blank pads. The user may install snubber networks to allow switching inductive loads.

The TSS48's many special features make it suited to a variety of applications. The long life, bounceless operation, consistent channel resistance over the life of the switch, and configuration flexibility qualify the TSS48 for many demanding manufacturing ATE test set-ups.

The large number of channels available supports applications such as functional board testing. Other special uses include: Audio switching; low-current power supply switching to the DUT; bias-voltage control; operations that require high repetition and long-life operations, such as component testing.

Each row and column is connected to two connectors, allowing easy expansion of the matrix in a row dimension, the column dimension, or both dimensions by adding TSS48 cards.

Option 01 incorporates the same matrix configuration but substitutes dry-reed switches in place of the mercury-wetted contacts. This substitution allows operation in environments which prohibit the use of mercury or in mechanical position-sensitive applications.

The TSS42 General-Purpose Scanner Card offers the same switches, but in a configuration suited to single-purpose test set-ups. The TSS48 is better suited to testing a varied series of DUTs. An example application is universal device test systems, which mix stimulus and measurement instruments on the same pins.

For ordering information, see page 428.

Relay-Driver Cards

High-Current Driver Card/60-mA Driver Card

- **Control Up to 24 User-Supplied Relays for Custom Applications**
- **Open Collector, NPN Darlington Drivers**
- **Allow 24 Channels of Control for Solenoids, Actuators, Handlers, and Other Devices**
- **Low-Voltage Detection Circuit Generates Error Message If Power Supply Fails**
- **Blank Prototype Area for User Wiring**
- **Back EMF Diodes for Switching Inductive Loads**

Two Current Driver Cards

The High-Current Driver Card (021-0417-00) and the 60-mA Driver Card (021-0418-00) are functionally identical.

Each driver card provides printed circuit board prototyping features for users who want to interface their own relays into the TSI 8150 Test-System Interface family. Uses for these cards include special relays such as optical switches, microwave transfer switches, and picoamp low-current switches.

Other uses include driving dc devices such as air valves, solenoids, handlers, and actuators. These cards provide easy interface of the devices to the General Purpose Interface Bus (GPIB) IEEE Standard 488.

The card's output drivers contain internal diodes that clamp the back EMF generated by a relay-coil opening to the coil supply voltage. Coil voltage for the relays passes through a limiting fuse. The return path connects to chassis ground.

Command Functions Available

All of the TSS40 command functions are available for the driver cards. The configuration command always returns 1 of 24. On the 021-0417-00, multiple switch channels can be closed simultaneously, providing the total current does not exceed 4 A. Other features available on these prototype cards include: sequence storage, break-before-make and make-before-break capability, timing control, and user-programmable bounce timing.

A TSI Family Member

The 021-0417-00 and 021-0418-00 driver cards conveniently interface user-supplied relays and other devices to the TSI 8150 Test-System Interface mainframe. The 021-0417-00 switches up to 1 A per channel; the 021-0418-00 switches up to 60 mA per channel.

The driver cards are controlled by a TSS40 Scanner-Control Assembly mounted in a TSI 8150 mainframe. The cards can be mounted in the TSI 8150 mainframe or mounted outside and connected to the TSI 8150 mainframe with a mass-terminated ribbon cable, up to 12-meters (40 ft) long.

PHYSICAL CHARACTERISTICS

	021-0417-00 High-Current Driver Card		021-0418-00 60-mA Driver Card	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	35.6	1.4	35.6	1.4
Height	178	7.0	178	7.0
Depth	307	12.1	307	12.1
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	0.4	0.8	0.3	0.7
Shipping	0.5	1.0	0.5	1.1

ENVIRONMENTAL

Ambient Temperature—Operating: 0 to +50 °C. Nonoperating: −40 to +75 °C.

For ordering information, see page 428.

TSI Family Scanner Modules

The TSI-Family of scanner modules are controlled by a TSS40 Scanner-Control Assembly mounted in a TSI 8150 Test-System Interface mainframe. Each module contains an expansion connector that allows the user to connect additional units without requiring an additional TSS40.

The modules can be mounted in a TSI 8150 mainframe or mounted outside and connected to the TSI 8150 mainframe with a mass terminated ribbon cable, up to 12-meters (40 ft) long.

CHARACTERISTICS

PHYSICAL CHARACTERISTICS

	TSS44		TSS45		TSS46	
Dimensions	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
Width	74	2.9	74	2.9	74	2.9
Height	184	7.3	184	7.3	184	7.3
Depth	89	3.5	89	3.5	89	3.5
Weights ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	0.5	1.0	0.5	1.0	0.4	1.0
Shipping	0.6	1.4	0.6	1.4	0.6	1.4

TSI 8150-FAMILY SCANNER MODULE SELECTION GUIDE

Features	TSS44	TSS45*1	TSS46
Insertion Loss (any port to common)	<0.1 at 100 kHz <0.25 at 50 MHz <1.0 at 200 MHz	<0.75 at 800 MHz <1.0 at 1.2 GHz <3.0 at 2.0 GHz	<0.1 at 3.0 GHz <0.3 at 12 GHz <0.5 at 18 GHz
Isolation (any port to common)	>80 dB at 100 kHz >45 dB at 50 MHz 40 dB at 200 MHz	>60 dB at 800 MHz >50 dB at 1.2 GHz >40 dB at 2.0 GHz	>90 dB at 3.0 GHz >70 dB at 12 GHz >60 dB at 18 GHz
Crosstalk (between any two ports with common and all unused ports terminated)	>80 dB at 100 kHz >45 dB at 50 MHz >40 dB at 200 MHz	>50 dB at 800 MHz >40 dB at 1.2 GHz >30 dB at 2.0 GHz	>90 dB at 3.0 GHz >70 dB at 12 GHz >60 dB at 18 GHz
VSWR (any port to common)	<1.05:1 at 100 kHz <1.2:1 at 50 MHz <2.1:1 at 200 MHz	<1.3:1 at 800 MHz <1.5:1 at 1.2 GHz <3.5:1 at 2.0 GHz	<1.1:1 at 3.0 GHz <1.3:1 at 12 GHz <1.5:1 at 18 GHz
Maximum Switched Current	500 mA dc or peak ac	10 mA dc or peak ac	50 mA dc or peak ac
Maximum Switched Voltage	150 V dc or peak ac	24 V dc or peak ac	15 V dc or peak ac
Maximum Carry Current	1.0 A	100 mA	3.0 A
Maximum Switchable Power	10 W (resistive) 200 mW (RF into 50 Ω)	200 mW (RF into 50 Ω)	125 mW (RF into 50 Ω)
Maximum Carry Power	500 mW (RF into 50 Ω)	500 mW (RF into 50 Ω)	450 W to 100 MHz 200 W to 700 MHz 100 W to 3.5 GHz 50 W to 1.8 GHz (all into 50 Ω)
Dielectric Standoff	250 V dc or peak ac	50 V dc or peak ac	50 V dc or peak ac
Switch Life	5×10^7	10^5	10^6
Settling Time	4 ms	31 ms	41 ms
Power Requirements	24 V dc coil supply in TSI 8150 mainframe or from external source		
Environmental	Operating: 0 to +50°C; Nonoperating: −40 to +75°C		

*1 *Two 1×6 binary trees (only one port can be connected to common at once).*

TSS44

Coax Scanner Module

- **Two Independent 1×6 Trees**
- **Shield-Common Isolated From Chassis Ground, Preventing Low-Frequency Ground-Loop Problems**
- **High Level of Isolation and Low Crosstalk for Low-Level Measurements**
- **BNC Connectors for Easy and Economical Interconnections**

A Versatile Coax Scanner Module

The TSS44 Coax Scanner Module multiplexes moderate bandwidth signals through shielded conductors.

The TSS44 uses coaxially shielded relays arranged in two 1×6 trees. Each channel consists of one switched signal wire and an unswitched shield that is common to the other shields in the same tree.

To eliminate low-frequency ground loops, the shield common is isolated from chassis ground.

The TSS44 fits into the TSI 8150 mainframe and 016-0862-00 Auxiliary High-Frequency Mounting Unit slots. This module also contains corner holes that permit the user to directly mount the TSS44.

For ordering information, see page 428.

TSS45

RF-Scanner Module

- **Two Independent 1×6 50-Ω Trees**
- **Wide Bandwidth for TDR and Communication Frequency Tests**
- **BNC Connectors for Easy and Economical Interconnections**
- **75-Ω Version Available**

A Versatile RF Scanner Module

The TSS45 RF Scanner Module multiplexes VHF/UHF signals in 50-Ω systems. Binary tree switching eliminates unterminated stubs and equalizes path length through all channels. Two independent 1×6 trees contain the switches.

The TSS45 provides an additional port—TERM—for terminating the common line when no channel is selected. TERM does not have the same path as the six ports.

Connecting A TERM to B COM forms a 1×12 tree with reduced specifications. Each channel consists of one switched signal wire and an unswitched shield that is common to the other shields and chassis ground.

The TSS45 can be used in areas such as: time-domain and frequency-domain testing through the UHF range; HF and VHF testing of frequency-domain devices without switch characterization in the high-frequency and very-high-frequency ranges; routing single-ended logic signals (for example, for GaAs testing; testing of general communications equipment).

For video or other applications requiring a 75-Ω environment, the TSS45 Option 01 is available. Specifications may vary slightly from those above.

The TSS45 fits into the TSI 8150 mainframe and 016-0862-00 Auxiliary High-Frequency Mounting Unit slots.

For ordering information, see page 428.

TSS46

Microwave Scanner Module

- **18 GHz Bandwidth (−0.5 dB) for Microwave Test Set-Ups**
- **Two Independent 1×6 Switch Trees**
- **SMA Connectors for Attaching Flexible and Semirigid Coaxial Signal Paths**

A Versatile Microwave Scanner Module

The TSS46 Microwave Scanner Module is designed to multiplex extremely high-bandwidth signals. The module's 18-GHz bandwidth and flat frequency response allow use in reduced-bandwidth systems without concern for insertion loss or rise-time degradation.

The TSS46 contains two independent 1×6 switch trees. Each channel consists of one switched signal wire and an unswitched shield that is common to the other shields and chassis ground.

This versatile high-frequency scanner module is useful in applications such as: UHF and low-end microwave testing without switch characterization; mulitplexing of TDR tests for hybrid, stripline, microstrip, and controlled-impedance board testing; broadband parametric testing that requires closing two switches simultaneously.

The TSS46 fits into the TSI 8150 mainframe and 016-0862-00 Auxiliary High-Frequency Mounting Unit slots.

For ordering information, see below.

ORDERING INFORMATION

TSI 8150 Test System Interface $2,995
Includes: Rackmounting hardware; user's manual (070-5765-03); configuration manual (070-5766-00); programming reference guide (070-6038-01); power cord.
TSX 8140 Expansion Chassis $2,495
Includes: Rackmounting hardware, instruction sheet, TSI 8150 interconnect cable and buffer board, ground strap, and power cord.

OPTIONS

Option 01—Replace standard configuration with front switch access. NC
Option 02—Configuration for front and rear switch access. +$595

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.
TSA 8140 Test System Adapter $495

CONVERSION KIT

Rackmount*1—Includes hardware for slide rails. Order TSA F01 $145
016-0861-00 Auxiliary Card Rack $250
016-0862-00 Auxiliary High-Frequency Mounting Unit $145
TSD42 32-bit Digital Interface $375
TSS40 Scanner Control Assembly $260
TSS41 Low-Level Scanner Card $545
TSS42 General-Purpose Scanner Card $625
TSS43 Power Switch Card $445
TSS48 Matrix Switch Card $675
021-0417-00 High-Current Driver Card $345
021-0418-00 60-mA Driver Card $245
TSS44 Coax Scanner Module $625
Includes: 0.91-m (36 in.) connection cable
TSS45 RF Scanner Module $945
Includes: 0.91-m (36 in.) connection cable
TSS46 Microwave Scanner Module $1,995
Includes: 0.91-m (36 in.) connection cable

OPTIONS

Option 01—(TSS41) For 1 μV thermal differential relays (2 μV with tree switch) +$400
Option 01—(TSS42/TSS48) Dry-reed relays NC
Option 01—(TSS43) 2-kV relays +$445
Option 01—(TSS45) 75 Ω +$100
Option 02—(TSS48) 2×16 matrix*1
Option 03—(TSS48) 2×16 matrix with dry-reed relays*1

*1 *Contact your local sales office for information.*

OPTIONAL ACCESSORIES
TSI 8150

System Service Manual—Order 070-5767-00 $50
Additional Main Interconnect Board—Order 670-9137-00 $595
Function Card Service Extender Package—Order 067-0162-00 $575

TSA 8140

Test Head Receiver*1—Compatible with test fixtures from Virginia Panel Corporation. Order 021-0435-00 $2,895
Interchangeable Test Adapters
(Full Size) Order 021-0434-00 $495
(Half Size) Order 021-0436-00 $475
(Extended Frame) Order 021-0441-00 $645
TSA F01 Rackmounting Hardware Kit $145
TSA F02 Hybrid Fixture (Leveling) Kit $275
TSA F10 Low-Frequency Quick Connect $375
TSA F11 High-Frequency Quick Connect $375

SCANNER/SWITCH DRIVER CARDS/ SCANNER MODULES

Auxiliary Card Mounting Rack—(TSS41/TSS42/TSS43/TSS48) Order 016-0861-00 $250
Extension Cable Kit—30.5-m (100 ft) cable and 24 connectors. Order 198-5579-00 $400
Cable Assembly—Six preassembled 2-m (6.5 ft) extension cables. Order 198-5581-00 $300
Auxiliary High-Frequency Mounting Kit—(TSS44/TSS45/TSS46) Order 016-0862-00 $145

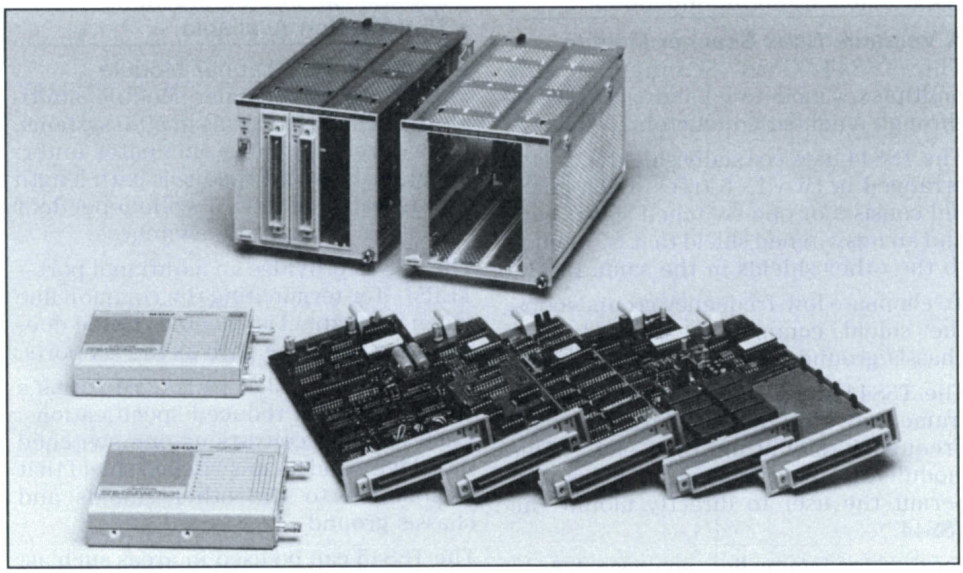
MI 5010/MX 5010

GPIB IEEE-488 The MI 5010 and MX 5010 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Wide Range of System-Interfacing Functions**
- **Up to Six Functions at One Address**
- **D-to-A, A-to-D Conversion**
- **Low-Level Signal Scanning**
- **Digital I/O**
- **Digital Word Acquisition and Generation**
- **Built-In Time-of-Day and Pacing Clock**
- **Common Buffer for Controller-Free Operation**
- **Thermocouple Scanning**

The MI 5010/MX 5010 Multifunction Interface System consists of the MI 5010 Multifunction Interface, the MX 5010 Multifunction Interface Extender, and seven different types of function cards. These cards are capable of a variety of functions typically required in automated test-system interfacing, data acquisition and generation, and process control.

The MI 5010 and MX 5010 each house up to three function cards, in any combination. The MI 5010 provides the communication between the system controller and the function cards. The MX 5010 is always used with an MI 5010, extending its control to six function cards at one GPIB address.



Multifunction Interface System

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

The function cards presently available for the MI 5010/MX 5010 Multifunction Interface System are: 50M10 Analog-to-Digital Converter, 50M20 Digital-to-Analog Converter, 50M30 Digital I/O, 50M40 Relay Scanner, 50M41 Low-Level Scanner (with M41A1 through M41A8 Signal Conditioners), 50M50 Memory, and 50M70 Development card. Each function card contains its own ROM with the specific firmware and its own unique set of commands required for its particular function. Each card can be operated in any slot of the MI 5010 and/or MX 5010 regardless of the other cards in the system.

In addition to providing the interface between the function cards and the system controller, the MI 5010 also has its own intelligence and a built-in command buffer. This buffer is capable of storing up to 300 system commands and executing them in sequence, paced by the on-board time-of-day and pacing clock or by signals from the system under test. It requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system

IEEE Standard 488-1978 Interface Function Subsets Implemented—SH1, AH1, T6, L4, SR1, RL0, PP0, DC1, DT1, C0.

ORDERING INFORMATION

MI 5010 Multifunction Interface **$1,760**
Includes: Instruction manual (070-3712-00); instrument interface guide (070-5187-00); reference guide (070-3882-00).
MX 5010 Interface Extender **$740**
Includes: Same as above.
Utility Software
For TM 5000/4041 Order 062-6958-01 **$150**
See System Support section for description and ordering information. This utility software supports all of the 50Mxx Series function cards also.

50M10 Programmable A/D Converter

- **12-Bit Resolution**
- **32-μs Conversion Time**
- **Four Voltage Ranges ±100 mV to ±100 V**
- **Data Transfer via GPIB or Front-Panel Connector**

The 50M10 uses a 12-bit successive approximation conversion technique with a track-and-hold amplifier to achieve a total conversion time of 32 μs or less (approximately 30,000 conversions per second). Using the front panel connector, conversion values can be sent over the GPIB (via the MI 5010) or to external memory devices (such as the 50M50 Memory card). In either case, data is transferred in two 8-bit bytes. The lower six bits contain the converted value, high byte followed by low byte. The seventh bit is a high-low byte indicator. The eighth bit is unused.

Four voltage ranges are provided, manually selectable by on-board jumpers: +100 mV, +1 V, +10 V, and +100 V. The total span for each range is divided into 4096 parts (12-bits). The front-panel analog input connections (high and low) can be elevated to a potential of +340 volts, dc plus peak ac.

Two handshaking modes are provided, one for communication with devices faster than the 50M10 (the device can accept data as fast as the 50M10 can provide it), and the other for communication with devices slower than the 50M10 (the 50M10 must be clocked by the external receiving device). Front-panel control lines permit the 50M10 conversions to be triggered, gated, or triggered within a gate. Through the use of a gateable function generator, such as the Tektronix FG 501A, and a digital delay generator, such as the Tektronix DD 501, a counted burst of conversions at a selected rate can be gated.

CHARACTERISTICS

Maximum Conversion Rate—32 μs.
Maximum Aperture Time—≤400 ns.
Accuracy (Full Scale)

Range	+18 to +28°C	0 to +50°C
100 mV	±0.15%	±0.25%
1 and 10 V	+0.075%	±0.125%
100 V	±0.125%	±0.2%

Amplifier Settling Time—100-mV Range: ≤150 μs. 1-V Range: ≤25 μs. 10-V Range: ≤10 μs. 100-V Range: ≤30 μs.
Input Impedance—100-mV, 1-V and 10-V Ranges: $\geq 10^{10}$ Ω. 100-V Range: ≥1 MΩ.
Digital-Data Transfer Format—12-bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

ORDERING INFORMATION

50M10 Analog-to-Digital Converter Card **$895**
Includes: Interfacing cable (015-0430-00); instruction manual (070-4495-00); reference guide (070-4491-00).

50M20 Programmable D/A Converter

- **12-Bit Resolution**
- **Voltage or Current Mode**
- **20-μs (Maximum) Conversion Time**
- **250 V RMS Isolation**
- **Mnemonic Instructions**
- **Self-Test and Error Indicators**
- **UL 1244 Listed**

The 50M20 converts digital data to either analog voltage or current. The voltage or current mode is selectable manually via an on-board switch.

Data format is 12 bits, sent in two sequential 7-bit words. Data can be sent via the IEEE Standard 488 (GPIB) using the MI 5010 as the interface, or from an external (front connector) bus for high-speed data transfer (with appropriate handshake lines). On-board firmware will convert commands and data to the proper format to perform the required digital-to-analog conversion. Two lines at the front-panel connector are provided to handshake data into the 50M20 from the user's external system.

Programming of the 50M20 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M20, control the source and the format of the digital data. The 50M20 can be programmed to respond to either external or internal system triggers.

CHARACTERISTICS

VOLTAGE MODE

Range—−10.240 to +10.235 V.
Accuracy—±10.0 mV (+20 to +30°C) ±15 mV (0 to +50°C).
Resolution (1 LSB)—5 mV.
Total Conversion Time (Maximum)—20 μs.
Output Ripple and Noise—<5 mV p-p at 5-MHz BW.
Output Current Range—0 to ±5 mA.

CURRENT MODE

Range—−20.48 to +20.47 mA.
Accuracy—±20 μA (+20 to +30°C) ±40 μA (0 to +50°C).
Resolution (1 LSB)—10 μA.
Total Conversion Time (Maximum)—20 μs.
Output Ripple and Noise—<15 μA, p-p, at 5-MHz BW.
Compliance Voltage—±11 V.
Isolation—250 V RMS maximum to ground.
Digital-Data Transfer Format—12-bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

ORDERING INFORMATION

50M20 Digital-to-Analog Converter Card **$910**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3724-01); reference guide (070-3883-00).

50M30

Programmable Digital Input/Output Card

- **16 Digital Input and 16 Digital Output Lines**
- **Data Entry/Output Formats in Decimal, Binary, or Hex**
- **Triggered Externally or On Command**
- **Mnemonic Instructions**
- **Self-Test and Error Indicators**
- **UL 1244 Listed**

The 50M30 provides 16 digital input and 16 digital output lines. The digital inputs accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. The digital outputs provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The digital outputs can be configured for open-collector outputs by positioning internal jumpers and using power supplied by the user.

Programming of the 50M30 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M30, control the selection of the data input/output channels and the arming/trigger functions of the card.

Four lines at the front-panel connector operate as input/output pairs to handshake data with the user's external system. One handshake pair allows the user's data source to be synchronized with the 50M30 data-input register and the other handshake pair allows the user's data storage device to be synchronized with the 50M30 data output register.

CHARACTERISTICS

Data Outputs Using Internal Supply— 16 open-collector TTL with 2 kΩ pullup resistors. Logical "1": +5 V ±2% (open circuit). Source current is −2.5 mA ±7% maximum. Logical "0": 0.2 V. Sink current is −40 mA maximum.

Data Outputs Using External (User) Supply—Maximum Voltage: +15 V. Pullup Resistors: 2 kΩ. Logical "1" equal to external supply voltage (open circuit). Source current is 7.5 mA ±5% plus external supply tolerance. Logical "0": 0.2 V. Sink current is 40 mA maximum.

Data Inputs—Input Buffers: 16 Schmitt triggers. Logical "1" (+V Threshold): +1.6 V ±25%. Source current is −0.14 mA nominal, −0.16 mA maximum. Logical "0" (−V Threshold): +0.8 V ±40%. Source current is −0.18 mA nominal, −0.21 mA maximum.

ORDERING INFORMATION

50M30 Digital Input/Output Card **$495**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3722-00); reference guide (070-3884-00).

50M40

Programmable Relay Scanner Card

- **16 Mercury-Wetted Relay Contacts**
- **User-Configurable 1, 2, 4 Groups**
- **Triggered Externally or On Command**
- **Mnemonic Instructions**
- **Self-Test and Error Indicators**
- **UL 1244 Listed**

The 50M40 provides 16 independent, normally open relay contacts. The relay contacts can be used as switch closures to supply power to several external points from one source, or scan several sources and supply various inputs to a single measurement device.

The desired relay switch pattern is configured by the user with internal jumpers. When the configuration has been established, the relay-scanning sequence, open and close operations, and triggering events are programmed over the IEEE Standard 488 (GPIB) Bus.

Two logic signal lines on the front-panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 microprocessor that the user is ready for the relay switch configuration to close. Three possible configurations are:

4 groups of 4 individual relays
2 groups of 8 individual relays
1 group of 16 individual relays

CHARACTERISTICS

Type of Relays—Mercury wetted reed.
Possible Configurations (Jumper Selectable)—1 of 4, 4 each. 1 of 8, 2 each. 1 of 16, 1 of 12, and 1 of 4, 1 each.
Maximum Applied Voltage—40 V dc plus peak ac.
Maximum Carry Current—1 A.
Breakdown Voltage—100 V dc plus peak ac.
Contact Resistance—0.15 Ω nominal (end of life).

ORDERING INFORMATION

50M40 Relay Scanner Card **$695**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3723-00); reference guide (070-3885-00).

50M41

Programmable Low-Level Scanner

- **10 Differential Contact Pairs Plus Guard**
- **<1 μV Thermal Offset**
- **User Configurable**
- **Handshake Lines to Permit External Control**
- **Isothermal Amplifiers Available for Thermocouple Applications**

The 50M41 provides ten pairs of guarded, normally open relay contacts with less than one microvolt of thermal offset in each channel. Each differential pair of contacts is accompanied by a third contact to switch the shield or guard connection. The ten sets of relay contacts can be configured as two groups of five individual relays with two commons, or as one group of ten individual relays with one common. The desired relay switch pattern is configured by internal jumpers. A tree relay can be included in the 1 of 10 configuration to reduce capacitive loading and potential noise problems when using more than one 50M41 in a system. Two handshake lines are provided for externally controlling the 50M41.

A family of high-gain, low-noise signal conditioning modules—M41A1 through M41A8—is available to condition low-level signals for specialized applications with the 50M41.

CHARACTERISTICS

Type of Relays—10 sealed low thermal EMF relays configurable as one 10-to-1 switch or two 5-to-1 switches.
Thermal Offset—<1 μV differential; <2 μV differential with tree switch.
Maximum Scan Rate—≥200 cycles/s.
Maximum Applied Voltage (High, Low or Guard of Any Channel to Chassis)—350 V dc + peak ac.
Maximum Switched Voltage—150 V dc + peak ac (not to exceed V A rating).
Maximum Carry Current—250 mA.
Maximum Switched Current—10 mA.
Maximum Switched V A—0.15.

ORDERING INFORMATION

50M41 Low-Level Scanner Card **$995**
Includes: Interfacing cable (015-0430-00); instruction manual (070-4557-00); reference guide (070-4556-00).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

M41A1

Low-Level Amplifier for 50M41

- **10 Differential Inputs plus Guard**
- **Selectable Gains of 1, 10, 100, and 1000**
- **Software-Selectable Filter**
- **External Handshake Lines**
- **50M41 Low-Level Scanner Required**

The M41A1 is a general-purpose amplifier with switchable gain in decade steps from 1 to 1000. Provision is made for a guarded input that can be driven by the amplifier's guard driver or by an external signal source. A software-selectable low-pass filter with a corner frequency of approximately 4 Hz provides more than 60 dB of normal-mode rejection at 60 Hz. The frequency response with the filter turned off is approximately −3 dB at 10 kHz.

CHARACTERISTICS

Gain Ranges

Overall Gain (A)	Input Gain (A)	Buffer AMPL Gain	Output Dynamic Range
1000	1000	1	10 V
100	1000	0.1	1 V
100	100	1	10 V
10	100	0.1	1 V
10	10	1	10 V
1	10	0.1	1 V

Gain Accuracy—±0.1% from +18 to +28°C; ±0.2% from 0 to +50°C

Maximum Input Voltage (Respect to System Ground)—250 V ac RMS (350 V dc + peak ac)

Input Resistance Differential—>10 MΩ paralleled with 0.05-μF capacitor.

RMS Noise (Referred to the Input)—<60 nV/$\sqrt{Hz}$ A=1000. <200 nV/$\sqrt{Hz}$ A=100. <500 nV/$\sqrt{Hz}$ A=10.

FILTER

Bandwidth Filter On—f(−3 dB): ≤6 Hz. f(−60 dB): ≤60 Hz.

Bandwidth Filter Off—>10 kHz.

Settling Time—Filter On: ≤400 ms. Filter Off: ≤150 μs.

ORDERING INFORMATION

M41A1 Low-Level Amplifier **$50**

Includes: Instruction manual (070-4605-01).

M41A2–M41A8

Thermocouple Amplifiers for 50M41

- **10 Guarded Inputs**
- **Selectable Hardware or Software**
- **Temperature Compensation**
- **Software-Selectable Filter**
- **External Handshake Lines**
- **50M41 Low-Level Scanner Required**

Signal-conditioning modules M41A2 through M41A8 are thermocouple amplifiers, each designed to operate with a specific thermocouple type (J, K, E, T, S, R, and B, respectively). The thermocouple amplifier provides isothermal connections for up to ten guarded or unguarded thermocouple pairs. Each amplifier provides hardware compensation for its specific thermocouple type; provision for software compensation is made where all thermocouples are not of the same type. Thermocouples are available from your local supplier.

CHARACTERISTICS

Maximum Thermocouple Wire Resistance—10 kΩ.

Linearity Error—±0.02% or 1 μV referred to input (whichever is greater).

Common-Mode Rejection Ratio—Incremental DC: ≥100 dB. 60 Hz: ≥100 dB.

Input Dynamic Range (Common Mode)—±10 V.

Incremental Input Resistance (High to LO)—>10 MΩ paralleled by 0.05-μF capacitor.

FILTER

Bandwidth Filter On—f(−3 dB): ≤6 Hz. f(−60 dB): ≤60 Hz.

Settling Time—Filter On: ≤400 ms. Filter Off: ≤150 μs.

ISOTHERMAL BLOCK

Temperature Gradient—<0.1°C between any two terminals or any terminal and temperature sensor.

Hardware Compensation—±0.014 (V − V_{iso}) A (°C) and 0.35°C (0 to +50°C) or 0.25°C (+18 to +28°C).

Software Compensation—0.35°C (0 to +50°C) or 0.25°C (+18 to +28°C).

ORDERING INFORMATION

The following thermocouple amplifiers each include instruction manual 070-4605-01.

M41A2 Type J	**$50**
M41A3 Type K	**$50**
M41A4 Type E	**$50**
M41A5 Type T	**$50**
M41A6 Type S	**$50**
M41A7 Type R	**$50**
M41A8 Type B	**$50**

50M50

Programmable Memory Card

- **16K-byte Digital Input/Output**
- **Single 16-Bit or Dual 8-Bit Channels**
- **Independent Dual-Channel Operation**
- **200-kHz Acquisition or Generation Rate**
- **TTL Levels**
- **External Handshake Lines**

This 16K-byte digital input/output device can be configured, under program control, as a single 16-bit input/output port or as two 8-bit input/output ports. These ports can be connected to any of 16 data buffers, which can be programmed to different lengths. The total memory of all the buffers cannot exceed 16K bytes.

The 50M50 is intended to be used as a digital-word generator and/or as a fast, digital-data acquisition buffer. As a digital-word generator, it can be used with a digital-to-analog converter, such as the Tektronix 50M20, to function as an arbitrary waveform generator. As a high-speed data-acquisition buffer, it can be used with an analog-to digital converter, such as the Tektronix 50M10, as an off-line, high-speed analog signal-measurement system or as a waveform digitizer.

The 50M50 can be programmed to input or output data on two different channels simultaneously, or to input data on one channel while outputting data on the other channel. System commands to the 50M50 control the selection of input/output channels, the control of the data buffers, and the arming functions of the card.

Four handshake lines are provided at the front panel to permit synchronization with the user's external system (one pair for each channel). Other external control lines permit pacing and control of data output and disabling of data input.

CHARACTERISTICS

Data Outputs—8 or 16 low-power Schottky TTL lines. Logical "1": +5 V ±2% (open circuit). Source current is 2.5 mA +2% −7% maximum. Logical "0": ≤0.7 V. Sink current is 40 mA maximum.

Data Inputs—8 or 16 low-power Schottky TTL lines. Logical "1" (+V Threshold): +1.5 to +2 V. Source current is −0.16 mA maximum. Logical "0" (−V Threshold): +0.6 to +1.1 V. Source current is −0.21 mA maximum.

Maximum Data-Transfer Rate—8-Bit Bytes: 200 kHz ±2%. 16-Bit Bytes: 125 kHz ±2%.

ORDERING INFORMATION

50M50 Memory Card **$995**
Includes: Interfacing cable (015-0430-00); instruction manual (070-4550-01); reference guide (070-4554-00).

50M70

Programmable Development Card

- **32 Data I/O Ports**
- **Interrupt and Trigger Lines**
- **Vector Board Development Region**
- **Mnemonic Instructions**
- **Self-Test and Error Indicator**

The 50M70 provides the means of developing a unique circuit and interfacing it to the GPIB without the need for designing and building the GPIB interface itself. With the 50M70, the user can create a specialized function card to be used in the MI 5010/MX 5010 Multifunction Interface System. When completed, the circuit can be programmed in high-level language over the GPIB.

The 50M70 contains two 68B21 16-bit interface-logic registers (PIAs), address and data buffers, its own firmware, and a 4×4 inch breadboard area for circuit development. The 32 data lines of the PIAs can be individually programmed as inputs or outputs. The PIAs also provide three sets of programmable two-wire handshake lines to permit triggering of the external system by the 50M70 or of the 50M70 by the external system.

Typical 50M70 applications are specialized A/D and D/A converter functions, counter/timer applications, special communication interface functions, keyboard and display functions, digital comparators for triggering and interrupt functions, etc.

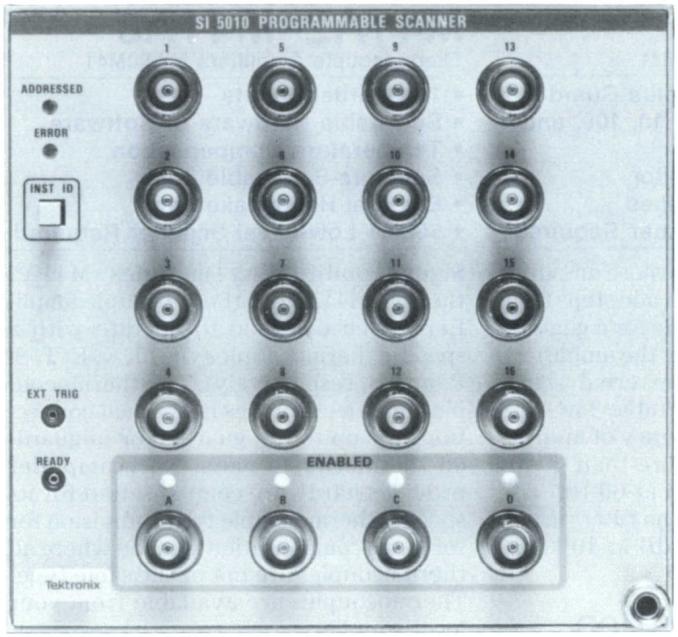
CHARACTERISTICS

Data Input/Outputs and Handshake Lines—Output High Level: +2.4 V minimum, +5.5 V maximum. Maximum Load Current: −200 μA. Output Low Level: 0 V minimum, +0.4 V maximum. Maximum Sink Current: 3.2 mA. Input Load Current: 1.3 mA nominal, 2.4 mA maximum.

DC Voltage Sources Available on the Card—+26 and −26 V ±9%, 100 mA maximum; +8 V ±5%, 600 mA maximum; +5 V ±5%, 1.5 A maximum. Total Combined Power Limit: 7.5 W.

ORDERING INFORMATION

50M70 Development Card **$410**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3725-00); reference guide (070-3886-00).



SI 5010 Programmable Scanner.

OPTIONAL ACCESSORIES MULTIFUNCTION INTERFACE SYSTEM

Interfacing Cable—50-conductor flat ribbon cable with connector to mate with front-panel connector of any Multifunction Interface System function card. Other end of the 48-inch cable terminates in bare tinned leads. (This cable is a standard accessory with 50M20, 50M30, 50M40, and 50M70 cards.) Order 015-0430-00 **$80**

Single-Width Interfacing Adapter—Mates with any single Multifunction Interface System function card to permit customized interface wiring between cards or to external system under test. Will accommodate up to five screw-terminal blocks (131-3083-00 below). Order 015-0466-00 **$175**

Screw-Terminal Block—Mounts in 015-0466-00 Interfacing adapter above to permit wiring changes without soldering (ten terminals per block). Order 131-3083-00 **$10.25**

Triple-Width Interfacing Adapter—Mates with up to three Multifunction Interface System function cards in an MI 5010 or MX 5010 to permit interface wiring among cards or to external system under test. Contains two 131-3083-00 screw-terminal blocks. Order 015-0473-00 **$265**

Multifunction Interface System Card Extender—Permits operation of a function card while extended from the front of an MI 5010 or MX 5010. Order 067-1066-00 **$175**

Function Card Access Shield—Dummy function card of insulating material to protect against possible electrical shock or damage in partially filled MI 5010 or MX 5010. Order 020-0836-00 **$65**

SI 5010

GPIB IEEE-488

The SI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Software Configurable as:**
  - **1 Group of 16 Channels**
  - **2 Groups of 8 Channels**
  - **4 Groups of 4 Channels**
- **350-MHz Bandwidth in 4-Channel Configuration**
- **External Handshake Lines**
- **Built-In Time-of-Day and Pacing Clock**
- **Command Buffer for Controller-Free Operation**

The SI 5010 Programmable Scanner provides the capability of switching and routing up to 16 high-frequency input and/or output signals. It always maintains a clean 50-Ω environment through the use of 50-Ω coaxial reed relays. The software-configurable basic four-channel arrangement allows the SI 5010 to be used for point-to-point switching (any connector to any other connector), or to be used in a wide variety of fan-in and/or fan-out configurations.

The SI 5010 has its own intelligence and a built-in command buffer capable of storing up to 300 system commands and executing them in sequence. It is paced by the on-board time-of-day and pacing clock or by signals from the system under test. This requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

Two handshake lines are provided for externally controlling the SI 5010. An Ext Trig line is provided to allow the SI 5010 switching to be initiated by the external system under test, and a Ready line indicates to the external system when the relays have settled.

CHARACTERISTICS

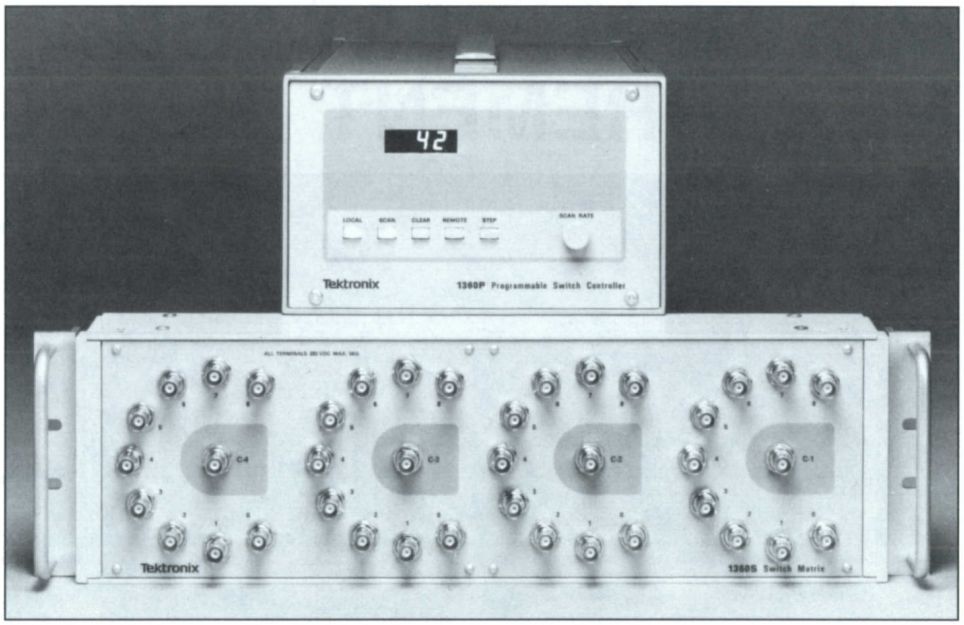
RF Connectors—20 BNC connectors, 16 channels and four commons.
Control Input (Ext Trig)—External Trigger: TTL compatible
Control Output Data Accepted (Ready)—TTL compatible. Output goes high when relays have settled.
Channel Configuration (Software Selectable)—1, 2, 3, or 4 groups of 4 channels. 2 groups of 8 channels. 1 group of 16 channels.
Frequency Response—Any 1 Group of 4: −3 dB at 350 MHz, decreasing to −6 dB at 500 MHz or greater. Any 1 Group of 8: −3 dB at 175 MHz or greater. Any 1 Group of 16: −3 dB at 80 MHz or greater.
Port (Channel) Isolation—40 dB at 100 MHz.
Characteristic Impedance (Each Channel)—50 Ω. See VSWR specification.
Rise Time (Each Channel)—<1 ns.
Voltage Standing Wave Ratio (VSWR)—Any 4 Channel Group: 1.25:1 at 100 MHz, increasing to 1.8:1 at 350 MHz. Any Other Combination: 1.5:1 at 100 MHz. 2:1 at 225 MHz.
Insertion Loss—<1 dB at 100 MHz.
Channel Delay Matching—Any Group of 4: 50 ps. Any Group of 8: 110 ps. Any Group of 16: 310 ps.
Type of Relays—16 Form A, EAC 05Y21A1 40 BAB, or equivalent. 4 Form "C", TO-5, Teledyne 712-6, or equivalent. Pull-In Time: 3 ms. Release Time: 3 ms. Breakdown Voltage: 350 V (dc + peak ac). Series Path Resistance (End of Life): 0.5 Ω.
Peak Carry Voltage—Unterminated: 40 V maximum. 50-Ω Terminated: 12.5 V maximum.
Peak Contact Current—0.25 A maximum.
Peak Switching Voltages—Unterminated: 15 V maximum. 50-Ω Terminated: 3.73 V maximum.
Peak Switching Current—0.01 A maximum.

ORDERING INFORMATION

SI 5010 Scanner **$2,275**
Includes: Instruction manual (070-3721-00); instrument interface guide (070-4615-00); reference guide (070-3881-00).
Utility Software
For TM 5000/4041 Order 062-6958-01 **$150**
See System Support section for description and ordering information.

RECOMMENDED PROBES
(See Accessories section.)

P6056—10X Passive. **$200**
P6057—100X Passive. **$195**
P6202A—FET. **$715**
P6230—Bias/offset. **$420**



1360P/1360S Programmable Signal Multiplexer

1360P/1360S

GPIB IEEE-488 The 1360P/1360S comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Signal Bandwidth to 300 MHz**
- **50-Ω Environment**
- **Selected Pole Readout**
- **Flexible Switch Configuration**
- **Rackmount or Benchtop**

The 1360P/1360S Programmable Signal Multiplexer is a microprocessor-based, GPIB-compatible system instrument that is used to multiplex electrical signals. The 1360P/1360S system includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix.

The 1360P Programmable Switch Controller is controlled via the GPIB and provides all the signals required for control of up to four 1360S Switch units. The 1360P is housed in an 8.5-inch wide (half-rackwidth) rackmount chassis, with right or left slider assemblies for rackmounting.

The 1360S Switch Matrix contains four 9-to-1 switches that can be cascaded to provide two 17-to-1 switches; a 25-to-1 switch and a 9-to-1 switch; or a 33-to-1 switch. Up to four 1360S Switch units can be controlled by one 1360P Controller unit to provide up to 129-to-1 multiplexing. In the 9-to-1 configuration, the 1360S has a signal bandwidth of 250 MHz; make/break time in all configurations is <1 ms. The switches in the 1360S can also be ganged together to provide simultaneous and synchronized multiplexing of several groups of signals.

The 1360S is housed in a 5.75-inch high, 19-inch wide rackmount chassis 3 inches deep.

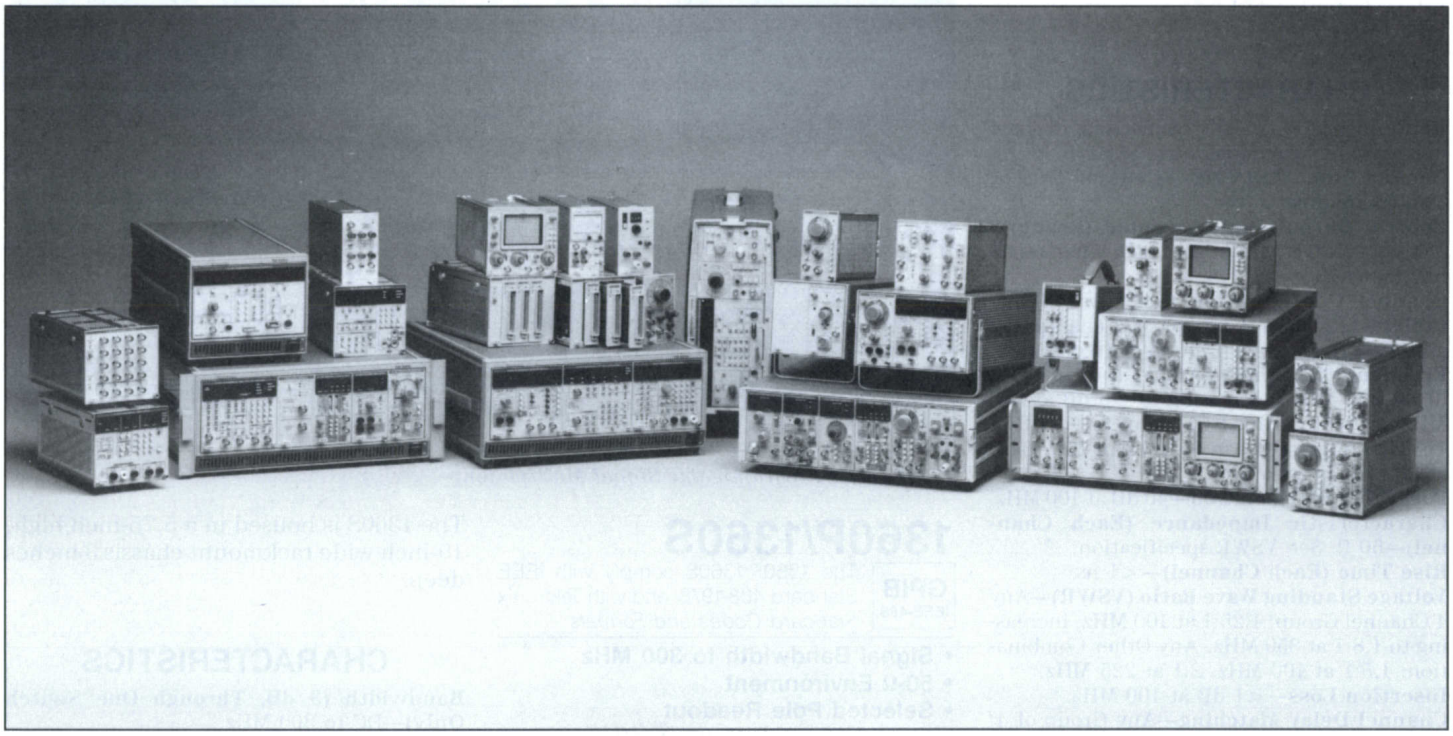
CHARACTERISTICS

Bandwidth (3 dB, Through One Switch Only)—DC to 300 MHz.
Maximum Input Voltage—250 V dc + peak ac (not to exceed 10 V A).
Maximum Carry Current—250 mA (not to exceed 10 V A).
VSWR (Through One Switch Only)—5.0 at 450 MHz; 3.9 at 400 MHz; 1.9 at 250 MHz; 1.2 at 100 MHz.
Characteristic Impedance—50 Ω ±1 Ω.
Scan Rate Variability—>10 s to <3 ms.
Make/Break Time—≤1 ms.

ORDERING INFORMATION

1360P Switch Controller **$2,695**
Includes: Instruction manual (070-3476-00).
1360S Switch Matrix **$1,695**
Includes: Same as above.

MODULAR TEST-AND-MEASUREMENT INSTRUMENTS



CONTENTS

Digital Counters/Timers
Selection Guide 437
DC 5010 Programmable and DC 510 Universal 439
DC 5009 Programmable and DC 509 Universal 439
DC 504A 439
DC 503A Universal 440
DP 501 Digital Prescaler 440
Digital Multimeters
Selection Guide 441
DM 5010 Programmable 442
DM 502A 442
DM 501A 442
Probes and Optional Accessories 443
Function Generators
Selection Guide 445
FG 5010 Programmable 447
FG 507 2-MHz Sweeping 447
FG 504 40-MHz 447
FG 503 3-MHz 447
FG 502 11-MHz 448
FG 501A 2-MHz 448
DD 501 Digital Delay 449
Pulse Generators
Selection Guide 450
PG 508 50-MHz 451
PG 507 50-MHz Dual Output 451
PG 502 250-MHz 451
PG 501 50-MHz 451
Power Supplies
Selection Guide 452
PS 5010 Programmable Triple 453
PS 5004 Programmable Precision 453
PS 503A Triple 453
PS 501-1 Floating 453
Audio Products
SG 5010/AA 5001 Programmable Audio-Test System 454
AA 501A Distortion Analyzer 457
SG 505 100-kHz Oscillator 458
Signal Conditioners
AM 503 Current-Probe Amplifier . . 461
A6303, A6302 Current Probes 461
AM 502 Differential Amplifier 461
AM 501 Operational Amplifier 461
Oscilloscopes
Selection Guide 463
SC 504 80-MHz Dual Trace 464
SC 503 10-MHz Dual Trace Storage 464
SC 502 15-MHz Dual Trace 464
SC 501 5-MHz 464
CG 5001 Programmable Oscilloscope-Calibration Generator 466
PG 506 Calibration Generator 467
TG501 Time-Mark Generator 467
SG 503 250-MHz Signal Generator 467
SG 504 1050-MHz Signal Generator 467
SG 502 500-kHz Oscillator 468
Electrical-to-Optical Converters
OT 501/OT 502/OT 503 Optical Transmitters 469
Optical-to-Electrical Converters . . 469
OR 501/OR 502 Optical Receivers 469
Mainframes
TM 5003/TM 5006 (for TM 5000 and TM 500 Modules) 470
TM 501, TM 502A, TM 503A, TM 504, TM 506, and RTM 506 (for TM 500 Modules) 471
TM 515 Traveler (for TM 500 Modules) 471
Accessories 472
Signal Routing/DUT Interfacing Products 420

Manual and GPIB-Programmable Instruments that Perform in Hundreds of Combinations

Functionality, configurability, and ease of use are all hallmarks of the TM 500 and TM 5000 lines. These instruments provide the answers to a broad range of test-and-measurement needs. You can choose from over forty ready-to-go, compact plug-ins to create multifunction packages for a wide range of applications or to solve unique application problems.

Instruments include digital counters, digital multimeters, a digital delay, function generators, pulse generators, signal generators, signal amplifiers, audio oscillators, an audio-distortion analyzer, oscilloscopes, oscilloscope-calibration instruments, power supplies, and three different blank plug-in kits for customizing special functions. Additional instruments, including programmable scanners, D/A and A/D converters, and a user-configurable development card, are listed and described in the "Signal-Routing/DUT-Interfacing Products" section of this catalog.

Each TM 5000 instrument (with the exception of the completely automatic AA 5001) is fully programmable—all front-panel functions are programmable over the GPIB (IEEE Standard 488 Interface Bus). Each instrument (again with the exception of the AA 5001) has a front-panel ID button that can be programmed to cause the instrument to generate an SRQ when pushed or to allow operator intervention in an on-going test. conversely, the SRQ-generation capability can be programmed off to prevent inadvertent operator interruption of a test. Plus, the entire front panel of each instrument can be locked out to further prevent operator interference with a test or instrument setup. When used with the execute-only version of the Tektronix 4041 System Controller, this means you can place a completely operator-proof test system on the manufacturing floor; the operator can intervene only to the extent permitted by the test programmer.

In addition, Tektronix *Standard Codes and Formats* provide standardized data formats among all TM 5000 instruments, and among all other Tektronix GPIB instruments. Standardized instrument-data formats open up the lines of bus communication and make your test-and-measurement system easy to set up and operate. Test and control functions are changed quickly and easily. Common error codes among instruments greatly simplify error-handling routines.

All of the TM 5000 instruments have diagnostics capability built right in. Each instrument performs an extensive diagnostic self-test on power-up, or on command and, in case of a fault, displays and/or sends over the GPIB an error message indicating the nature of the fault. To further aid in troubleshooting and maintenance of the instruments, each has built-in signature-analysis capability; each instruction manual gives a comprehensive list of signatures at nodes throughout the instrument.

The Right Solution Requires the Right Mainframe

Combine your instruments with the correct mainframe for your environment. For the TM 500 line of manual instruments, there's a travel mainframe for service work and field testing; a rackmount model for production and test; or standard mainframes, compact and convenient for bench or desk, that accept one to six instruments. Rollabout carts are available for lab configurations with Tek oscilloscopes.

All TM 500 instruments and mainframes are electrically and mechanically compatible. Plus, all of the TM 500 manual instruments can be used in TM 5000 mainframes, side-by-side with the TM 5000 GPIB-programmable instruments. This compatibilty yields cost-effective solutions to system applications where not all functions or measurements need to be programmed. Cost efficiency is as important a part of the TM 500 concept as solving applications problems. You add on performance capabilities when you need them, using the same mainframe and power supply as before.

The TM 5000 instruments operate in either TM 5003 or TM 5006 mainframes to form compact, configurable, automated test systems that occupy less than half the rack space of ordinary rack-mounted equipment. The TM 5003 has three compartments, the TM 5006 has six. All of the current TM 5000 instruments are double-width, with the exception of the single-width DC 5009 and PS 5004 and the triple-width CG 5001.

Adherence to standard form and fit means that TM 5000 products can be replaced in a system without the uncabling, unstacking, restacking, and recabling that is necessary with most instruments. Rebuilding the system for a different task takes seconds, not hours.

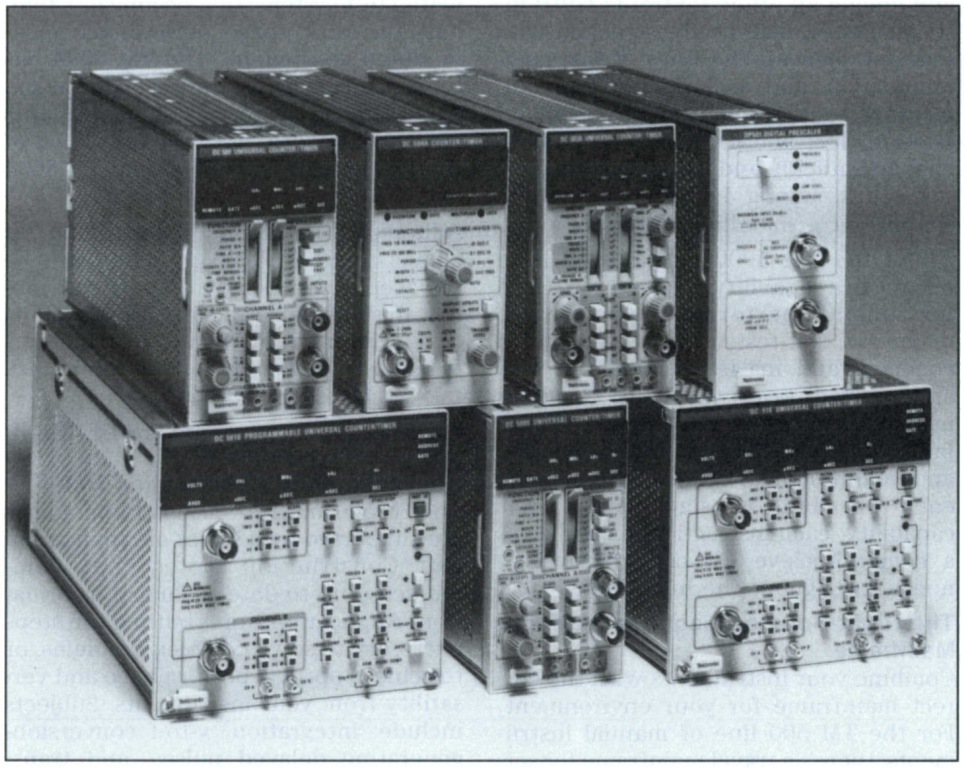
All TM 5000 instruments are UL listed.

Application and Construction Notes

The TM 500 and TM 5000 instrument lines are supported by a series of Application and Construction Notes that communicate up-to-date technical information. Application Notes outline the steps necessary to solve complex problems, or to achieve optimal performance and versatility from your instruments. Subjects include: integration, v-to-f conversion, generating delayed pulses, and transducer measurements.

Construction Notes provide information to build custom circuits using a blank plug-in kit and standard components. These notes are developed from the actual construction of more common special circuits, and include parts lists, schematics, and other construction details. Some of the available notes include power-supply circuits, thermal true rms converter, and analog multipliers.

DIGITAL COUNTER/TIMERS



A Counter for Every Purpose

The TM 500/TM 5000 family provides a selection of five digital counters, each with its own performance and price niche, plus a prescaler that adds 1.3-GHz frequency-measurement capability.

The 350-MHz DC 5010 and DC 510, and the 135-MHz DC 5009 and DC 509, are universal counter/timers that feature reciprocal frequency measurements and an especially wide range of other measurement functions, plus features such as autotrigger, auto-averaging, arming, probe compensation, and more. The DC 5010 and DC 5009 are GPIB programmable; this capability can be added to the DC 510 and DC 509 as field modifications. In performance other than programmability, the DC 510 and DC 5010 are equal, as are the DC 5009 and DC 509.

For versatility in counting, the DC 503A 125-MHz Universal Counter/Timer features eight measurement functions, including period, width, and time-interval averaging. Both input channels have the full 0 to 125-MHz frequency range, 20-mV RMS sensitivity, and separate controls for input coupling, attenuation, trigger level, and trigger slope. The 10-MHz clock provides 100-ns resolution of single-shot time interval measurements, and 10-ps resolution with averaging.

The 100-MHz DC 504A features autorange, period and width averaging, and a 100X resolution multiplier to provide high resolution of low-frequency signals.

The DP 501 Digital Prescaler adds 1.3-GHz frequency-counting capability to all of the above counters except the DC 504A.

Microprocessor Based, High Performance

The DC 5010/DC 510 and DC 5009/DC 509 are microprocessor based and contain high-performance features available only in such instruments. These counters use a powerful dual-register architecture to obtain high-resolution counting of low-frequency signals. The DC 5010 and DC 510 provide nine digits of resolution in about a third of a second; the DC 5009 and DC 509 provide eight digits of resolution in about a second. The DC 5010 and DC 510 provide 3.125-ns single-shot resolution for time-interval measurements; the DC 5009 and DC 509 provide 10-ns resolution. With averaging, the DC 5010 and DC 510 can provide 1-ps resolution on time-interval measurements; the DC 5009 and DC 509, 5-ps resolution.

Other features available include autotrigger, autoaveraging, probe compensation, and diagnostic self-test. At the push of a button, the autotrigger feature senses the top and bottom of the applied signal and automatically sets the trigger point midway between the two.

Autoaveraging provides the optimum combination of resolution and measurement time, regardless of the frequency of the signal. Both autotrigger and autoaveraging can be overridden to allow manual (or programmable, in the case of the GPIB versions) control of averaging, measurement time, and triggering levels.

The probe-compensation feature lets the user quickly and accurately compensate a high-impedance probe to the instrument input impedance directly. Improperly compensated probes are a common source of timing errors when using counters without this feature.

All of these instruments include an arming input and shaped outputs for added versatility when measuring selected parts of complex waveforms.

All feature a phase-modulated time base to eliminate clock-synchronous errors in all time-averaging modes.

In addition to all the features of the DC 5009 and DC 509, the DC 5010 and DC 510 permit direct measurement and display of rise time and fall time.

The addition of the GPIB interface board (a field modification) converts both the DC 510 and DC 509 into their fully programmable, fully GPIB-compatible versions, the DC 5010 and DC 5009, respectively.

Accessory Probe

An optional accessory probe, the Tektronix P6125, has been especially designed for use with digital counters. The 5X attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. Low input capacitance permits acquisition of high-frequency signals with minimum loading of the circuits under test.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

DIGITAL COUNTER/TIMER SELECTION GUIDE

Characteristic	DC 5010/DC 510	DC 5009/DC 509	DC 503A	DC 504A
	Channels A and B Input			**Input**
Frequency Range & Sensitivity (mV, RMS sine wave) 50-Ω Termination	25, dc to 350 MHz 70-V p-p pulse			
1-MΩ Termination	AC Coupling: 25, to 200 MHz; 42, to 300 MHz	20, to 100 MHz; 40, to 135 MHz. 115 mV p-p at min. pulse width of 3 ns.	20, to 100 MHz; 35, to 125 MHz. 60 mV p-p at min. pulse width of 5 ns; 100 mV p-p at min. pulse width of 4 ns.	30, to 100 MHz; 85 mV p-p at min. pulse width of 5 ns.
Trigger-Level Range (V)	+2 to −2	+3.200 to −3.175	±3.5	±2
Resolution (mV) (X1 attenuation)	4	25	—	—
Accuracy	±2%	±45 mV ±40 μV/°C	±0.5%	—
Autotrigger Frequency Range (Hz)	10 to 350 M	20 to 100 M	—	—
	Channel A Frequency			
Range	36 μHz to 350 MHz	100 μHz to 135 Hz	DC to 125 MHz	DC to 100 MHz
Resolution*1	±LSD ±1.4 (ATJE/N) ×(freq. A)²	±LSD ±1.4 (TJE/N) ×(freq. A)²	0.1 Hz to 10 MHz in decade steps	Selectable
Accuracy	Resolution ±(TBE×freq. A)	Resolution ±(TBE×freq. A)	±1 count ±TBE×freq. A	±1 count ±TBE×freq.
	Period			
	Channel A		**Channel B**	
Range	3.125 ns to 7.6 hr	7.40 ns to 3.05 hr	100 ns to 10^9 s	
Resolution	±LSD ±1.4 (ATJE/N)		100 ns to 10 s in decade steps	
Accuracy	Resolution ±TBE×Period A		±1 count ±TBE×Period B±1.4×B (TJE)	
			Average	
Range			8 ns to 10 s	DC to 2.5 MHz
Resolution			1 fs to 100 ns	100 ns to 100 ps
Accuracy			±(100 ns/N) ±TBE×Period ±1.4 (TJE/N)	
Events Averaged (N)			1 to 10^8	1 to 10^3
	B/A Ratio		**A/B**	
Range	10^{-8} to 10^9 (36 μHz to 350 MHz)	10^{-7} to 10^8 (CH A, to 135 MHz; CH B to 125 MHz)	1 to 10^8 (DC to 125 MHz)	
Resolution	±LSD ±1.4 [(BTJE) (Freq. B)]/N			
Accuracy	Same as Resolution		±Freq. B/[(Freq. A)(N)] ±1.4 [(BTJE)(Freq. A)] ÷N±Freq. A/0.3×10^8	
	Time A→B			
Range	2.0 ns to 7.6 hr	15 ns to 3.05 hr	12.5 ns to 10 s	
Min. Dead Time (stop to start)	12.5 ns	15 ns	12.5 ns	
Resolution	±LSD +(1/N)(+ATJE±BTJE)		100 ns $(N)^{-1/2}$	
Best Time A→B Average Resolution	±1 ps			
Accuracy*2	Resolution ±(TBE)(Time A→B) +(BTSE)−(ATSE)±Ch delay mismatch			
Channel Delay Mismatch	<2 ns	<2 ns		
Repetition Rate	<70 MHz	<35 MHz		

*1 *TJE=Trigger Jitter Error;=Ch A TJE, etc.*
TBE=Time-Base Error
*2 *See individual instrument specifications.*

Selection Guide continued next page.

DIGITAL COUNTER/TIMER SELECTION GUIDE

Characteristic	DC 5010/DC 510	DC 5009/DC 509	DC 503A	DC 504A
		Events B During A	**Events A During B (average)**	
Range	10^{-8} to 10^{9}	10^{-7} to 10^{8}		
Max B Freq	350 MHz	125 MHz		
Max A Freq	80 MHz		125 MHz	
Min Pulse Width	4 ns (A)	15 ns (A)	5 ns (B)	
Min Time Between Pulses	8.5 ns	15 ns		
Min Dead Time	≤8.5 ns	15 ns		
Events Averaged (N)	—	—	1 to 10^{8}	
		Width		
	Channel A		**Channel B**	
Range	4 ns to 7.6 hr	15 ns to 3.05 hr	100 ns to 10^{9}s	
Min Dead Time	1.6 ns	15 ns		
Resolution	±LSD +1/$N^{1/2}$ ±start TJE ±stop TJE		100 ns to 10 s	
Accuracy*2				
Repetition Rate	50 MHz	—	—	
			Average	
Range			5 ns to 10 s	DC to 2.5 MHz
Resolution			100 ns/$N^{1/2}$	±100 ns/$N^{1/2}$
Events Averaged (N)			1 to 10^{8}	1 to 10^{3}
Accuracy*2				
Freq Range			DC to 100 MHz	
		Time Manual		
Range	0 to 3.125×10^{4} s (≈8 hr)	0 to 3.05 hr	*2	
Resolution	±LSD (100 ms)			
Accuracy	±Resolution ±TBE×time			
		Totalize		
		A		
Range (counts)	0 to 10^{9}	0 to 1.09×10^{12}	1 to 99,999,999	
Repetition Rate	0 to 350 MHz	0 to 135 MHz	125 MHz Max	DC to 10 MHz
	A+B			
Range (counts)	0 to 10^{9}			
Repetition Rate	0 to 350 MHz			
	A−B			
Repetition Rate	0 to 350 MHz			
	Rise/Fall			
Range	4 ns to 10^{4} s (50Ω) 5 ns to 10^{4} s (1 MΩ)			
Repetition Rate (Min time between rising or falling edges)	12.5 ns (80 MHz)			
Input Amplitude (50 Ω)	(1.4 to 8 V)× atten.			
(1 MΩ)	(0.7 to 4 V)× atten.			
Resolution & Accuracy*2				
		Time Base		
Frequency		10-MHz Crystal		10 MHz
Temperature Stablity		$\pm2\times10^{-7}$, 0 to 50°C	*2	
Warm-Up Time		$\pm2\times10^{-7}$ of final frequency in <10 min at 25°C		
Aging Rate*2				
Setability		Adjustable to within $\pm2\times10^{-8}$		
Prices	$4,610/$4,110	$2,775/$2,275	$1,440	$965

*1 *TJE=Trigger Jitter Error; ATJE=Ch A TJE, etc. TBE=Time-Base Error*

*2 *See individual instrument specifications.*

DC 5010/DC 510

GPIB IEEE-488 The DC 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **350 MHz both A and B Channels**
- **3.125-ns Single-Shot Resolution**
- **9-Digit Display**
- **1-ps Resolution, with Averaging**
- **Measurement Functions Include: Reciprocal Frequency Measurement; Period; Width; Time A→B; Events B During A; Totalize A, A+B, A−B; Ratio; Rise/Fall; Time Manual; Arming; Null**
- **Auto or Selected Averaging to 10^9 in All Modes**
- **Duty-Cycle Independent Autotrigger**
- **DVM Mode for Displaying Trigger-Level Setting**
- **Shaped A and B Channel Outputs**
- **Hysteresis Compensation**
- **Probe Compensation**

Frequency measurements to 350 MHz (to 1.3 GHz with the Tektronix DP 501 Digital Prescaler), a wide range of time-interval measurement capabilities including rise and fall times, hysteresis compensation, probe compensation, arming, and high resolution on low-frequency signals (up to nine digits in one second or less), all combine to make the DC 5010/DC 510 true state-of-the-art universal counter/timers. Selected averaging of up to 10 events provides usable time-interval resolution to 1 ps on repetitive signals. The automatic averaging feature provides a compromise between measurement time and resolution, regardless of input-signal frequency. The pseudo-random, phase-modulated clock provides increased accuracy by eliminating the possibility of clock-synchronous errors in the time-interval averaging modes. Hysteresis compensation is automatic, further increasing the accuracy of time-interval measurements in the DC 5010/DC 510. The Null feature permits the nulling of differences in cable lengths in time-interval measurements to provide direct readout of the measurement of interest.

Autotrigger, at the push of a button or upon command over the GPIB, senses the maximum and minimum of the applied signal and sets trigger level to a point midway between the two, regardless of duty cycle. The values of the maximum and the minimum are available over the bus where they can be used by the controller to compute the p-p amplitude of the signal, providing the function of a high-frequency p-p DVM. The value of the trigger level is also available over the bus, and may also be displayed in the nine-digit DC5010 display. The outputs of both channels' signal-shaping circuits are available at the front panel to aid in the proper setting of trigger levels on complex waveforms. The arming input allows measurement of selected events within complex waveforms. The unique Probe Compensation feature permits quick and accurate compensation of attenuator-type probes to provide accurate measurements on signals beyond the amplitude range of the counter itself.

A field-installable modification kit is available to upgrade a manual DC 510 Universal Counter/Timer to a GPIB programmable DC 5010 Universal Counter/Timer.

OTHER CHARACTERISTICS

Display—Nine-digit LED display, automatic decimal point positioning, with LED indicators for units, measurement gate, and bus conditions. Overflow is indicated by a blinking display.
Power Consumption—14.5 V A.
GPIB Data Output Rate—≈10 readings/s maximum.
Power Module Compatibility—The DC 5010 is not compatible with TM 500 Series mainframes.

DC 5009

GPIB IEEE-488 The DC 5009 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **135 MHz Both A and B Channels**
- **10-ns Single-Shot Resolution**
- **8-Digit Display**
- **5-ps Resolution, with Averaging**
- **Measurement Functions Include: Reciprocal-Frequency Measurement; Period; Width; Time A→B; Events B During A; Totalize; Ratio; Time Manual; Arming**
- **Auto or Selected Averaging to 10^8 in All Modes**
- **Duty-Cycle Independent Autotrigger**
- **Shaped A and B Channel Outputs**
- **Probe Compensation**

The DC 5009/DC 509 single-width Universal Counter/Timers provide all of the measurement functions of the higher performance DC 5010/DC 510 except rise time/fall time, null, and totalize A±B.

The powerful reciprocal-frequency measurement technique allows up to eight digits of resolution of low-frequency signals in one second or less of measurement time. The DC5009/DC509 has the same automatic averaging feature as the DC 5010/DC 510; selected averaging of up to 10^8 events provides usable time-interval resolution of 5 ps.

Like the DC 5010/DC 510, the frequency-measurement capability of the DC 5009/DC 509 can be extended to 1.3 GHz with the use of the DP 501 Digital Prescaler. The TM 5000 rear-interfacing capability allows the operation of the DP 501 to be controlled over the GPIB through the DC 5009.

A field-installable modification kit is available to upgrade a manual DC 509 Universal Counter/Timer to a GPIB programmable DC 5009 Universal Counter/Timer.

OTHER CHARACTERISTICS

Display—Eight-digit LED display with automatic decimal point positioning, LED indicators for units and measurement gate. Overflow is indicated by a blinking display.
Power Consumption—≈12 V A
GPIB Data Output Rate—≈10 readings/s maximum.
Power Module Compatibility—The DC 5009 is not compatible with TM 500 Series mainframes.

DC 504A

- **DC to 100 MHz**
- **Period and Period Averaging**
- **Width and Width Averaging**
- **Autoranging**
- **100X Resolution Multiplier**

The easy-to-use DC 504A Counter/Timer measures frequency from dc to 100 MHz, with an internal prescaler being used for frequencies above 10 MHz. Both direct and prescaled counting are done through the same input connector; no need to change connectors when changing frequency range. Autoranging permits virtual hands-off operation for most measurements. The 100X resolution multiplier automatically provides 0.01-Hz resolution in one second or 0.001-Hz resolution in ten seconds on signals from 10 Hz to 25 kHz.

The DC 504A features period and width averaging of up to 1000 events. Selectable dc coupling of the input eliminates the potential errors associated with making width measurements on signals of varying duty cycle with counters that are only ac coupled. Input trigger sensitivity is 30-mV RMS across the entire 100-MHz frequency range. The trigger-level range of ±2 V and the selectable 5X attenuator provide a triggering range of up to ±10 volts.

The totalize mode permits totalizing up to 999,999 events—and beyond, with overflow—with a Display Update-Run/Hold control to hold the display while the internal counter continues to advance.

OTHER CHARACTERISTICS

Display—Six-digit LED readout with automatic decimal-point positioning and leading-zero suppression. LED annunciators indicate gate open, resolution multiplier lock, and display overflow.

DC 503A

- **125 MHz Both A and B Channels**
- **10-ps Resolution in Time-Interval Average with 10^8 Averages**
- **Measurement Functions Include: Frequency; Period and Period Average; Width and Width Average; Time A→B; Time A→B Average; Events A During B and Events A During B Average; Totalize; Time Manual; Ratio A/B Average**
- **40-MHz Rep Rate in Time-Interval Average**
- **Trigger-Level Outputs for Accurate Trigger Setting**
- **Simplified Width Measurements**
- **Trigger-Level Outputs for Accurate Trigger Setting**
- **Shaped Outputs for Ease of Triggering**
- **Designed for True Probe Compatibility**

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125-MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A, and an averaging feature allows averaging of 1 to 10 occurrences of the signal of interest. Signals to be counted or timed can be applied to channels A and B via front-panel BNC connectors or through rear-interface connections. The DC 503A features an easy-access front panel and an LSI-based design for increased instrument reliability.

The DC 503A is equipped with a temperature-controlled 10-MHz crystal oscillator to obtain a highly stable and precise internal time base.

OTHER CHARACTERISTICS

Display—Eight digit LED; indicators for units, gate open, and overflow.
Display Time—≈0.2 to 5 s and hold.

DP 501

- **Extends Frequency-Measurement Capability to 1.3 GHz**
- **Compatible with Most TM 500 and TM 5000 Counters**
- **AGC**
- **Low-Level Indicator**

The DP 501 Digital Prescaler adds 1.3-GHz frequency-counting capability to the Tektronix DC 503A, DC 509, DC 5009, DC 510, and DC 5010 Universal Counter/Timers.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal by 16 and causes the associated counter's display to be multiplied by 16, so that the counter will display the correct frequency. In the Direct mode, the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching when input signal frequencies occur in both the Prescale and Direct frequency ranges.

The prescaling function can be activated in either of two ways: manually, with a front-panel pushbutton; or, when used with the GPIB programmable DC 5009 or DC 5010, by a Prescale command to the counter. Thus, the DP 501 adds programmable frequency measurements to 1.3 GHz to the Tektronix TM 5000 Family of GPIB programmable instruments.

Input sensitivity in the Prescale mode is 20-mV RMS to 1 GHz and 30-mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting. An automatic gain-control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and DC 509/DC 5009 or DC 510/DC 5010 can be used with the Tektronix 7L14 Spectrum Analyzer and TR 502 Tracking Generator to provide counter-accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

CHARACTERISTICS

Prescale Mode—Input: Frequency range is ≤100 MHz to ≥1.3 GHz. Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (-21 dBm). 1 to 1.3 GHz is ≤30-mV RMS (-17 dBm). Impedance: 50 Ω, ac coupled; vswr ≤2.2:1. Output: Amplitude into 50 Ω is ≥200 mV, p-p. Unterminated is 2X terminated value.
Direct Mode—Input: Connected directly to output. Frequency Range: 0 to >350 MHz. Impedance: Loop-through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output). Output: Connected directly to input. <1-dB insertion loss up to 350 MHz. Powers up in direct mode.
Overload Protection—Prescale: Input disconnects when input signal exceeds +20 dBm +5 dBm for a period of ≈0.5 s or more.
Damage Level—Prescale: Input may be damaged if signal level exceeds +25 dBm. Direct: 42 V peak maximum. Maximum current is 250 mA.
Input Attenuation—Automatic: Up to 40-dB range.
Low-Level Indicator—Lights when input signal is below that required for error-free counting.
Tracking-Generator Compatibility—Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

ORDERING INFORMATION

DC 5010 Programmable Universal Counter/Timer **$4,610**
Includes: Shaped output cable (012-0532-00); instruction manual (070-3897-02); instrument interfacing guide (070-4611-00); reference guide (070-3553-01).
DC 510 Universal Counter/Timer **$4,110**
Includes: Same as DC 5010 except instruction manual (070-3552-01).
DC 5009 Programmable Universal Counter/Timer **$2,775**
Includes: Tip jack to BNC adapter cable (175-3765-01); instrument interfacing guide (070-4612-00); reference guide (070-3560-01); instruction manual (070-3888-00).
DC 509 Universal Counter/Timer **$2,275**
Includes: Instruction Manual (070-3464-00).
DC 504A Counter/Timer **$2,275**
Includes: Instruction manual (070-4291-00).
DC 503A Universal Counter/Timer **$1,440**
Includes: Instruction manual (070-2971-00).
DP 501 Digital Prescaler **$585**
Includes: Instruction manual (070-4332-00).

UTILITY SOFTWARE

For TM 5000/4041. See System Support section for description.
Order 062-6958-01 **$150**

CONVERSION KITS

IEEE Standard 488 Capability—
(DC 510) Order 040-1023-05 **$320**
(DC 509) Order 040-0957-04 **$325**

OPTIONAL ACCESSORIES

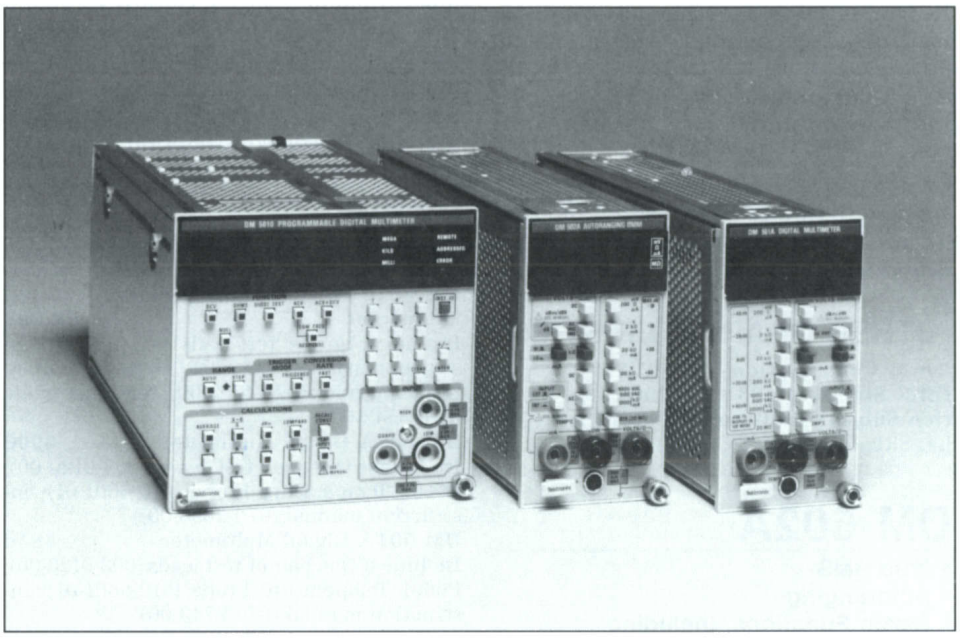
Power Divider — GR, 50 Ω.
Order 017-0082-00 **$800**
Adapters —
(GR to BNC female) Order 017-0067-00 **$55**
(GR to BNC male) Order 017-0064-00 **$100**
Cable Adapters —
(BNC to tip jack) DC 503, DC 509, DC 5009. Order 175-3765-01 **$32**
(BNC to RF) DC 510, DC 5010. Order 012-0532-00 **$37**

RECOMMENDED PROBES

P6125—5X Passive **$75**
P6101A — 1X, dc to 34 MHz **$53**
P6106A — 10X, dc to 300 MHz **$140**
P6201 — FET, dc to 900 MHz **$1,250**
P6230 — Bias/Offset, dc to 1.5 GHz **$420**
P6056 — 50 Ω, X10, dc to 3.5 GHz **$200**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

DIGITAL MULTIMETERS



PRODUCT SUMMARY

Multimeter selections include the high-performance, programmable DM 5010 and two general-purpose instruments, the DM 501A, and DM 502A. The DM 5010 measures dc voltage, resistance, true rms ac voltage, and true rms ac+dc voltage, and offers 0.015% dc accuracy. It offers full GPIB-programmability in conformance with Tek *Standard Codes and Formats.*

The DM 501A and DM 502A provide exceptional versatility in function and range at relatively low cost. In addition to the usual ac and dc voltage, resistance, and ac/dc current functions, both meters offer a dB function and a platinum-resistance temperature-measurement function that provides digital readout of surface temperature in degrees C.

TM 5000 and TM 500 digital multimeters offer a compact solution to your measurement needs, without compromising wide performance range. These instruments provide accuracy and flexibility in laboratory bench, field service, and maintenance applications.

DIGITAL MULTIMETER SELECTION GUIDE

Application/Feature	DM 501A	DM 502A	DM 5010
Number of Digits	4½	3½	3½, 4½*1
DC Volts Ranges	200 mV to 1000 V	200 mV to 1000 V	200 mV to 1000 V
DC Volts Accuracy	±0.05%	±0.1%	±0.015%
DC Volts Best Resolution	10 μV	100 μV	10 μV
AC Volts Ranges	200 mV to 500 V	200 mV to 500 V	200 mV to 700 V
AC Volts Accuracy	±0.6%	±0.6%	±0.2%
AC Volts Best Resolution	10 μV	100 μV	10 μV
AC or DC Current Ranges	200 μA to 2 A	200 μA to 2 A	N/A
dB Ranges	+54 dB to −60 dB	+50 dB −60 dB	Calculated
Resistance (HI-LO) Ranges	200 Ω to 20 MΩ	200 Ω to 20 MΩ	200 Ω*2 to 20 MΩ
Temperature Measurement Range	−62 to +240°C	−55 to +200°C	N/A
True RMS	✓	✓	✓
Autorange	✓		✓
IEEE Standard 488			✓*3
Mainframe Compatibility	TM 500 or TM 5000	TM 500 or TM 5000	TM 5000
Prices Begin At	$850	$900	$2,260

*1 *Measurement rate of 26 readings/s at 3.5 digits resolution and 3 readings/s at 4.5 digits.*
*2 *Low Ω plus diode test.*
*3 *Fully programmable, IEEE Standard 488 compatible.*

DM 5010

GPIB IEEE-488

The DM5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **4½ Digit, Autoranging**
- **DC Volts, Ohms, True RMS (ac or ac+dc)**
- **Diode Test**
- **Comprehensive Math Functions: dB Calculations; Averaging; Offset; Scaling; Hi/Lo/Pass**

The internal math capability of the DM 5010 provides most of the calculations normally required for reducing raw measurements to decision-supporting information without controller assistance. These calculations include averaging (up to 19,999 measurements), offset and scaling, conversion to dBm or reference dB, and Hi/Lo/Pass comparisons. User-selectable constants required for calculations can be supplied either through the front-panel keypad or via the GPIB.

The internal math capability of the DM 5010 permits such specialized measurements as ac- or dc-current measurements through the use of an external shunt resistor and a scaling factor equal to the ohmic value of the resistor; comparison against a percent tolerance (as opposed to an absolute value tolerance) through the combined use of the scaling and Hi/Lo/Pass functions.

The low-voltage (0.2 V) ohms function allows in-circuit resistance measurements without turning on parallel diode and transistor junctions. A Diode Test function is provided for forward and reverse testing of diode and transistor junctions.

The versatile TM 5000 rear-interfacing capability allows signals to be applied to the DM 5010 via the rear interface connector as well as via the front-panel input jacks. This front-rear selection capability allows the rapid comparison of two signals or voltage levels, such as the input and the output of a device, without the need for external switching of the signal. Selection of front or rear signal input can be made under bus control or by front-panel pushbutton.

The DM 5010 is fully guarded, with the Guard connector automatically connected to the Low input when there is no Guard signal lead inserted.

The Null function eliminates much of the requirement for four-wire ohms connections by allowing the operator, or the system, to null out lead resistance in resistance measurements. The Null function also allows the difference between two measurements to be displayed, either directly or as a dB difference.

A special Low-Frequency Response function permits stable readouts of low-frequency ac voltages.

Range selection is either automatic or manually incremented. Measurements and calculations can be triggered by internal circuitry, a front-panel pushbutton, a rear-interface signal, or a GPIB command.

Calibration of the DM 5010 is greatly simplified through the use of internal microprocessor-computed nonvolatile calibration constants.

OTHER CHARACTERISTICS

Power Consumption—≈20 V A.
IEEE Standard 488-1978 Interface Function Subsets Implemented—SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0.

DM 502A

- **True RMS**
- **Autoranging**
- **Seven Functions, Including Temperature and dB**
- **0.1% DC Volts Accuracy**
- **3½-Digit Display**

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator-selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance, and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random, or other nonsinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 to 0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. A higher voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3½-digit display. Power consumption is approximately 8 V A.

DM 501A

- **0.05% DC Voltage Accuracy**
- **Seven Functions Including Temperature and dB**
- **4½ Digit Display**
- **True RMS Capability**

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB, and temperature. The DM 501A gives 4 digits of readout resolution, all with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted waveforms. Readout in dB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the Tektronix P6601 platinum-film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds. Power consumption is approximately 9 V A.

ORDERING INFORMATION

DM 5010 Programmable Digital Multimeter **$2,260**
Includes: One set test leads (003-0120-00); instruction manual (070-2994-01), instrument interfacing guide (070-4603-00); reference guide (070-3542-00).
DM 502A Digital Multimeter **$900**
Includes: One pair test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual (070-2693-00.)
DM 501A Digital Multimeter **$850**
Includes: One pair of test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual (070-2749-00).

OPTION

Option 02 — (DM502A/DM501A) Deletes P6601 Temperature Probe and temperature-measurement capability. **−$80**

UTILITY SOFTWARE (DM 5010 only)

See System Support section for description and ordering information.
For TM 5000/4041.
Order 062-6958-01 **$150**

OPTIONAL ACCESSORIES (DM 5010 only)

Test Leads —
(Black) 4 ft. Order 012-0425-00 **$12.75**
(Red) 4 ft. Order 012-0426-00 **$23**
(Black) 4 ft. Order 012-0426-01 **$23**
Test Lead Set — Includes 012-0425-00, 012-0426-00, and 013-0107-05. Order 012-0427-00 **$29**
Female-BNC-to-Dual-Banana Adapter—Order 103-0090-00. **$9.50**

RECOMMENDED PROBES (DM 5010 only)

High Voltage — To 40 kV. See Digital Multimeters Accessories section. Order 010-0277-00. **$180**
P6420 — RF, 2-m Probe. **$155**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

DIGITAL-MULTIMETER PROBES AND OPTIONAL ACCESSORIES

High-Voltage Probe

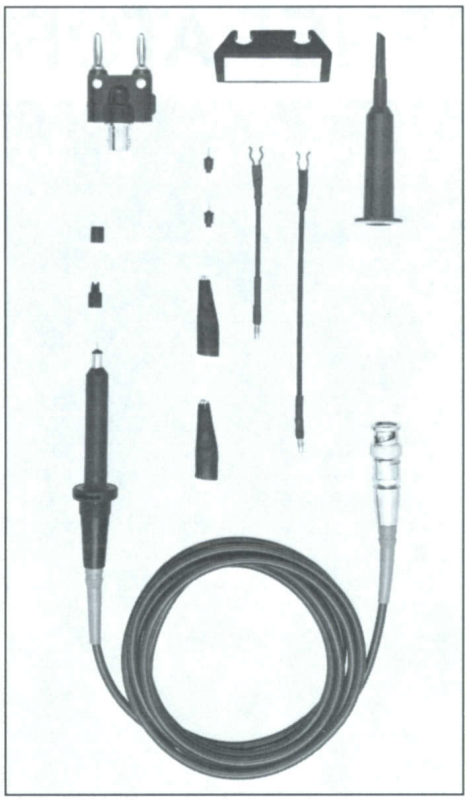
The High-Voltage Probe will measure dc voltages from 1 to 40 kV with an accuracy of 1% at 25 kV. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes. Probe plugs directly into the front end of the multimeter.

CHARACTERISTICS

Voltage Range—1 to 40 kV dc.
Input Resistance—1000 MΩ.
Division Ratio—1000:1.
Overall Accuracy—20 to 30 kV 2%.
Upper-Limit Accuracy—Changes linearly from 2% at 30 kV to 4% at 40 kV.
Lower-Limit Accuracy—Changes linearly from 2% at 20 kV to 4% at 1 kV.
Input Z at Meter—10 MΩ required.

ORDERING INFORMATION

High-Voltage Probe
Order 010-0277-00 **$180**



P6420 RF Probe

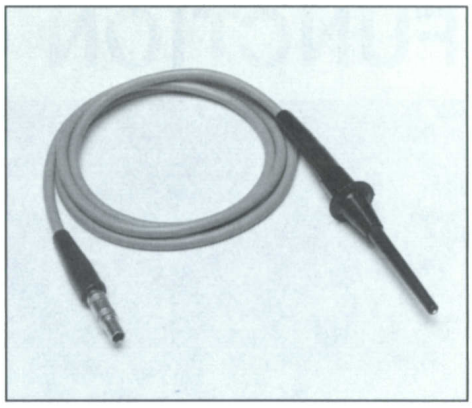
The P6420 RF Probe is compatible with DMMs that have an input impedance of 10 MΩ, and comes with a two-meter cable.

CHARACTERISTICS

Voltage Range—5 to 25 V RMS (70.7 V p-p).
AC to DC Transfer Ratio Accuracy—0.5 to 5 V RMS ±10% (+15 to +35 °C). 5.0 to 25 V RMS ±5% (+15 to +35 °C).
Frequency Response—100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).
Input Capacitance— ≈3.7 pF.
Maximum Input Voltage—42.4 V (peak ac + dc).
Length—Probe only 96 mm. Cable only 2 meters.

ORDERING INFORMATION

P6420 RF Probe, 2-m cable **$155**
Includes: Retractable probe tip (013-0097-01); BNC female-to-dual-banana adapter (103-0090-00); alligator clip (344-0046-00); probe holder (352-0351-00); 76.2-mm (3 in.) ground lead (175-0849-00); 152.8-mm (6 in.) ground lead (175-1017-00); two replaceable probe tips*[1]; electrical insulating sleeve (166-0404-01); data sheet (062 2764-00).
*[1] *Available in package of ten only. Order 206-0230-03.*
Cables—No specification changes.
(1 Meter) Order 175-1661-00 **$27**
(3 Meter) Order 175-1661-02 **$27**



P6601 Temperature Probe

The P6601 Probe is a temperature-measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature-sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the probe tip to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 seconds ±0.2 seconds. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a maximum of +240 °C, and the cable is limited to a maximum of +140 °C.

ORDERING INFORMATION

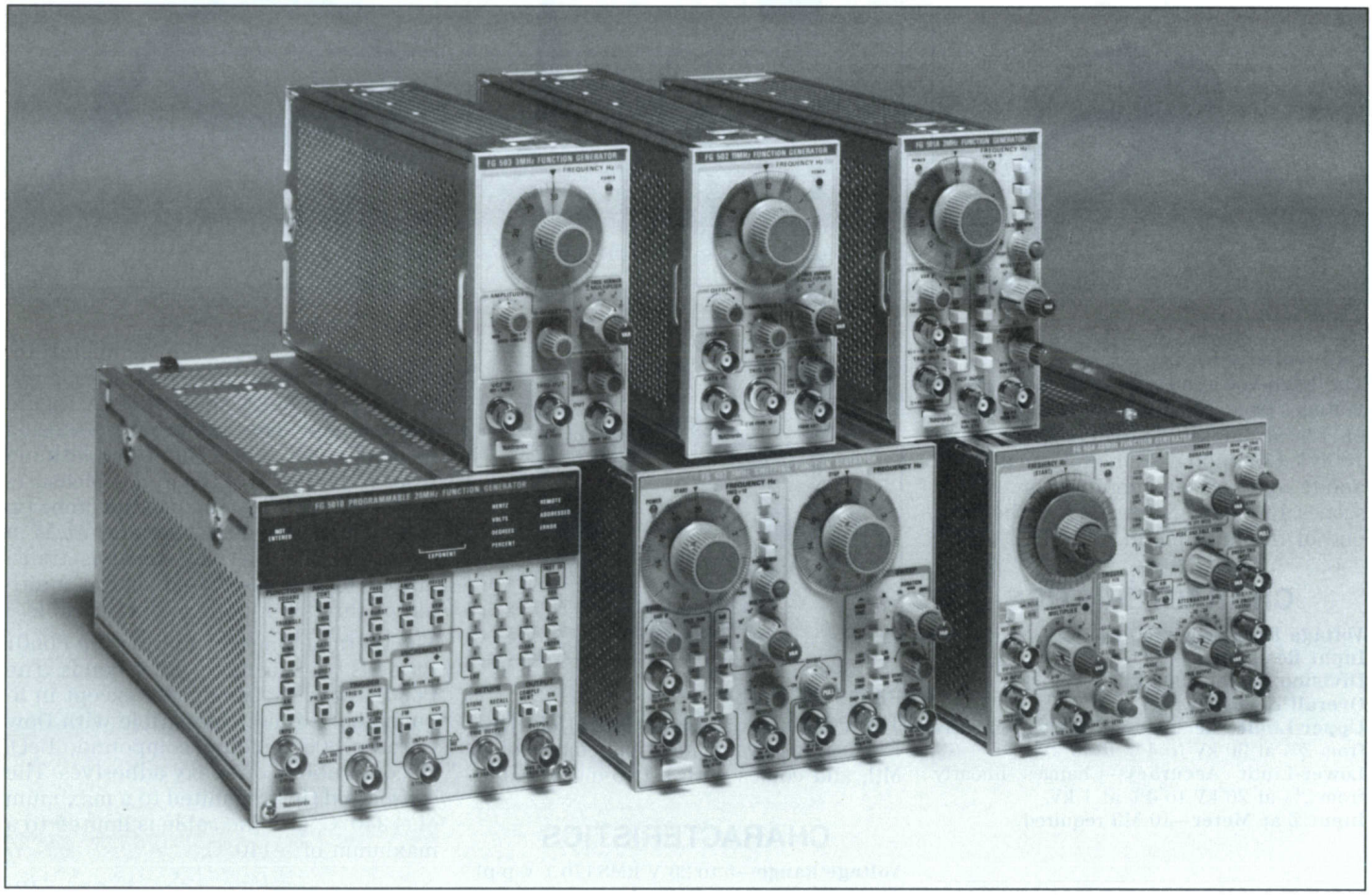
P6601 Temperature Probe
Order 010-6601-01 **$225**
Includes: Instruction manual (070-2620-00).

DMM OPTIONAL ACCESSORIES

The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.

Test Leads—
(Black, 4 ft) Order 012-0425-00 **$12.75**
(Red, 4 ft) Order 012-0426-00 **$23**
(Black, 4 ft) Order 012-0426-01 **$23**
Test Lead Set—
Includes: 012-0425-00, 012-0426-00, 013-0107-05. Order 012-0427-00 **$29**
Adapter—Female-BNC-to-Dual Banana. Order 103-0090-00 **$9.50**

FUNCTION GENERATORS



PRODUCT SUMMARY

When your test-and-measurement problems require more waveforms for more applications, the high-performance TM 5000 and TM 500 Function Generators are a versatile solution, either singly or in combination with one another.

If full GPIB programmability, accurate frequencies (within 0.1% of reading) to 20 MHz, variable symmetry, complementary output, as well as a host of other features are part of your application, consider the FG 5010.

For applications demanding logarithmic or linear sweep, the FG 507 offers an accurate and versatile solution. Low-distortion waveforms, combined with log and linear sweeps, are particularly useful in audio and linear communications-oriented applications.

For low-frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical, and mechanical simulations or on servo systems.

Applying an external ramp to the VCF input allows any of the TM 500 function generators to double as a sweep generator. Applying a suitable modulating signal can produce a frequency-modulated carrier. In addition, the FG 504 and FG 507 can supply internally generated linear or logarithmic sweeps with convenient two-dial control of start and stop frequencies.

Sweeping wide frequency ranges (up to 1000:1) with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform in the gated burst or triggered mode with the FG 501A, FG 504, FG 507, and the FG 5010. A gated or triggered waveform efficiently tests tone-controlled systems, loudspeaker transient-response characteristics, automatic-gain-control circuits, or other amplitude-sensitive systems.

The FG 504's phase-lock mode lets you convert digital signals to high- or low-voltage sine waves, pulses, or triangles; ideal for locking the function generator's output to a house or system frequency standard. With the DD 501 Digital Delay unit in the "divide by n" mode, the FG 504 can be locked to your frequency reference at a lower frequency.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

FUNCTION GENERATOR SELECTION GUIDE

Application/Feature	FG 501A	FG 502	FG 503	FG 504	FG 507	FG 5010
Waveforms Sine, Square, Triangle	✓	✓	✓	✓	✓	✓
Pulse, Ramp	✓	✓		✓	✓	✓
Symmetry (%)	≤5 to ≥95 Variable	5, 50, 95 Fixed	50 Fixed	7 to 93 Variable	≤5 to >95 Variable	10 to 90 1% steps
Frequency Range with var. symmetry	0.002 to 2 M 200 k±10%	0.1 to 11 M (1.1 M Pulse, Ramp)	1 to 3 M (0.01 to 5 M usable)	0.001 to 40 M 4 M	0.002 to 2 M 200 k±10%	0.002 to 20 M
Dial Accuracy % of full scale	≤3	≤3 to 1 MHz ≤5 to 10 MHz	≤5	≤3 to 4 MHz*1 ≤6 to 40 MHz*1	≤3 ≤5 in sweep mode *2	≤0.1 of selected frequency Digital LED Display
Custom Freq. Range	No	No	User-Installed C	C for 20 Hz to 20 kHz	No	NA
Frequency Stability % of full scale		≤0.05 for 10 min, ≤0.1 for 1 hr, ≤0.5 for 24 hrs, constant temp.				≤0.05 for 1 hr. ≤0.05 for 24 hrs.
Amplitude (Vpp) open circuit	30	10	20	30	30	20
into 50 Ω	15	5	10	15	15	10
Attenuator (dB) in 20-dB steps	0 to −60			0 to −50	NA	Digital control of fixed & variable 10 mV p-p into 50 Ω
with AMPL control	>20 additional				NA	
with VAR control		Variable control only		<10 mV p-p	NA	
Offset (V dc) open circuit	±13	±5	±7.5	±7.5	NA	±7.5
into 50 Ω	±6.5	±2.5	±3.75	±3.75	NA	±3.75
Peak Signal + Offset (V dc) open circuit	±15	±10	±15	±20	±15	±15
into 50 Ω	±7.5	±5	±6	±11.25	±7.5	±7.5
Output Impedance (Ω)	50	50	50	50	50	50
Amplitude Flatness (Hz) (10-kHz ref, 50-Ω load) Sine	±0.1 dB, 20 to 20 k; ±0.5 dB, 20 k to 1 M; ±1 dB, 1 M to 2 M	±0.5 dB, 20 to 20 k; ±1.5 dB, 0.1 to 11 M	±0.5 dB, 20 to 20 k; ±2 dB, 0.1 to 3 M	±0.5 dB, 0.001 to 40 k	±0.1 dB, 20 to 20 k; ±0.5 dB, 20 k to 1 M; ±1 dB, 1 to 2 M	±3%, 0.002 to 1 k; ±3.5%, 1 k to 1 M; ±5%, 1 to 5 M; +5%, −10%, 5 to 20 M
Triangle	±0.5 dB, 20 to 200 k; ±2 dB, 200 k to 2 M	±3 dB ref to Sine Wave	±1 dB ref to Sine Wave	±2 dB, 40 k to 40 M	±0.5 dB, 20 to 200 k; ±2 dB, 200 k to 2 M	±2%, 0.002 to 1 k; ±3.5%, 1 to 100 k; +4%, −5%, 1 to 5 M; +4%, −20%, 5 to 20 M
Square	±0.5 dB, 20 to 2 M	±3 dB ref to Sine Wave	±1 dB ref to Sine Wave	±0.5 dB to 20 M; ±2 dB to 40 M	±0.5 dB, 20 to 2 M	±2%, 0.002 to 1 k; ±3.5%, 1 k to 1 M; ±5%, 1 to 10 M; ±10%, 10 to 20 M
Sine-Wave Distortion (Hz, Maximum Output, 50-Ω load)	≤0.25%, 20 to 20 k*2; ≤0.5%, 20 to 100 k Harmonics: ≤−30 dB, 100 k to 2 M	≤0.5%, 10 to 50 k*2 Harmonics: ≤−30 dB at all other frequencies	≤0.5%, 1 to 30 k; ≤1 %, 30 to 300 k; ≤2.5%, 300 k to 3 M	≤0.5%, 20 to 40 k*1 Harmonics: ≤−30 dB, 40 k to 1 M; <−20 dB, 1 to 40 M	≤0.25%, 20 to 20 k*2; ≤0.5%, 20 to 100 k Harmonics: ≤−30 dB, 100 k to 2 M	±0.5%, 20 to 19.99 k ≤1%, 20 to 99.99 k Harmonics: >30-dB down, 100 k to 20 M
Square-Wave Response	≤25-ns rise/fall; <3% p-p aberrations	≤20-ns rise/fall; ≤3% p-p aberrations	≤60-ns rise/fall; ≤3% p-p aberrations	≤6-ns rise/fall fixed, 10 ns to 100 ms variable; ≤5% p-p +30 mV aberrations	≤25-ns rise/fall; <3% p-p aberrations	≤10-ns rise/fall; ≤5% p-p aberrations

*1 *15 to 35°C ambient.*
*2 *20 to 30°C ambient.*
*3 *20 Hz to 20 kHz modulation frequency.*
*4 *FG 504 requires forced-air circulation above 40°C.*
*5 *Percent of indicated frequency.*
*6 *Absolute voltage accuracy.*
*7 *Separate FM function (1%/V).*

Selection Guide continued next page.

FUNCTION GENERATOR SELECTION GUIDE

Application/Feature	FG 501A	FG 502	FG 503	FG 504	FG 507	FG 5010
Triangle Linearity (Hz 10 to 90%)	≥99%, 20 to 200 k ≥97%, 200 k to 2 M	≥99%, 0.1 to 100 k ≥97%, 100 k to 1 M; ≥95%, 1 to 11 M	≥99%, 1 to 100 k; ≥95%, 100 k to 3 M	≥99%, 10 to 400 k; ≥95%, 400 k to 40 M; ≥98%, 0.001 to 10 (typ.)	≥99%, 20 to 200 k; ≥97%, 200 k to 2 M	>98% to 2M; >90% to 20 M
Trigger Output (V_{peak})	≥+2 from 50 Ω	+2.5 to 50-Ω load	+2.5 to 600-Ω load	+2 from 50 Ω	≥+4 from 50 Ω	+ 2 from 50 Ω
External Input	Impedance ≈2 kΩ; Trigger threshold level +1 V±20%	Impedance ≈1 kΩ; ≥+2 V gate signal required	No	Impedance ≥10 kΩ; Sensitivity ≤1 V p-p; Trigger level; −1 to +10 V	Impedance ≈2 kΩ; Trigger threshold +1 V ±20%	1 MΩ/50 Ω selectable; 0.0 V/0.5 V selectable
Trigger	±90° variable start phase control	No	No	20 MHz maximum, ±80° start phase control to 10 MHz	±90° variable start phase control	
Gate	±90° variable start phase control	Fixed 0°	No	No		
Phase Lock (Hz)		No		100 to 40 M ±80° phase range	No	20 to 20 M (Auto Scan)
Counted Burst		with DD501		No	with DD501	1 to 9999
Internal Sweep		No		Log or linear, separate start/stop dials		No
Duration				0.1 m to 100	1 m to 100	
External Trigger		NA		+1 to 10 V trig level; 1 V sensitivity	±1 V ±20% trig level; ≈2 kΩ input	NA
Ramp Output				0 to +10 V from 1 kΩ ±5% to 1 ms, ±10% ≤1 ms	≤0.3 to 10 V from 1 kΩ ±5%	
Gate Output				No	≥+4 V from 50 Ω	
Other Modes				Manual sweep trig	Manual sweep trig; manual sweep; sweep and hold	
Amplitude Modulation		No		100% with ≈5 V p-p, DC to 100 kHz; <5% distortion to 4 MHz at 70%*3, <10% to 40 MHz at 65%*3	No	100% with ≈5 V p-p, DC to 100 kHz, <2% distortion to 2 MHz at 70%, <4% to 20 MHz at 70%
Voltage-Controlled Frequency (FM)*7		Up to 1000:1 frequency change with 10 V external signal.				
Slew Rate		Slew rate ≥0.3 V/μs. 10 kΩ input impedance.				N/A
Nominal Hz/V Sensitivity (X Frequency Multiplier except FG 5010)	2	1.1	3	4	2	10% of selected range
Output Hold Mode (Hz)		No		0.001 to 400	No	0.002 to 200
Price	$940	$1,110	$690	$3,275	$2,275	$3,995

*1 *15 to 35°C ambient.*
*2 *20 to 30°C ambient.*
*3 *20 Hz to 20 kHz modulation frequency.*
*4 *FG 504 requires forced-air circulation above 40°C.*
*5 *Percent of indicated frequency.*
*6 *Absolute voltage accuracy.*
*7 *Separate FM function (1%/V).*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

FG 5010

GPIB IEEE-488 The FG 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **0.002 Hz to 20 MHz**
- **Up to 20 V p-p From 50 Ω**
- **Sine, Square, Triangle, Pulse, and Ramp Waveforms**
- **10 ns Rise/Fall**
- **10 to 90% Variable Symmetry in 1% Steps**
- **Trigger, Gate, Counted Burst**
- **Phase Lock, With Autoscan**
- **AM, FM, VCF**
- **Waveform Complement**

The FG 5010 Programmable 20-MHz Function Generator is a highly versatile GPIB progammable instrument; it is also extremely easy to operate in the manual mode. All functions are addressable via the lighted front-panel pushbuttons, with nomenclature and functionality clearly designated. The ability to store ten complete front-panel setups and recall them with only two keystrokes or by a single command over the GPIB reduces GPIB programming and enhances standalone bench applications.

The FG 5010 provides the conventional sine, square, triangle, pulse, and ramp waveforms. Variable symmetry, which is usable throughout the entire frequency range, extends pulse and ramp capabilities beyond those of conventional generators. The FG 5010 also provides trigger, gate counted burst, phase lock, AM, FM, and VCF modes. Variable phase enhances the trigger, gate, burst, and phase-lock modes.

The wide frequency range ensures the FG 5010's usefulness in radio and other communications-oriented applications, as well as in low-frequency applications such as biological, geophysical, and mechanical simulations.

The FG 5010 maintains frequency accuracy within 0.1% over its full 0.002-Hz to 20-MHz frequency range. Automatic phase lock to an external signal is possible from 20 Hz to 20 MHz. Waveform complement and +/− trigger slope allow interfacing to circuits with the proper waveform phase, especially important in pulse and digital applications. Waveform hold can freeze the output voltage of any 200-Hz or less waveform at its instantaneous value. With the output amplitude set to zero volts, the dc offset can be programmed to provide a dc voltage source of 0 to ±7.5 V in 10-mV steps.

CHARACTERISTICS

Waveform—Sine, Square, and Triangle with variable Symmetry providing Pulses and Ramps.

Symmetry—10% to 90%, 1% steps, ±2% accuracy. Range above 4 MHz is limited by 25-ns minimum triangle transition time (decreases to 50% at 20 MHz).

Frequency—Range: 0.002 Hz to 20 MHz. Accuracy: Continuous mode, ±0.1%. Trigger, Gate, Burst Modes: Frequency ≤200 Hz, ±0.1%; frequency >200 Hz, ±5.0%. Resolution: Continuous mode, 4 digits, Trigger, Gate, Burst modes. Frequency ≤200 Hz, 4 digits. Frequency >200 Hz, 3 digits.

Amplitude—Range: 20 mV to 20 V p-p from 50 Ω into open circuit.

OTHER CHARACTERISTICS

Power Consumption—60 W.

IEEE Standard 488-1978 Interface Function Subsets Implemented—SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

FG 507

- **0.02 Hz to 2 MHz**
- **Includes All FG 501A Features**
- **Logarithmic or Linear Sweep**
- **Separate Start/Stop Frequency Dials**
- **Sweep Up or Down**
- **Sweep and Hold**
- **Manual Sweep**

The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use log- and linear-sweep capability.

The log sweep of the FG 507 is mathematically correct and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503. Separate start and stop frequency dials make frequency settings easy to adjust and interpret. The instrument can be internally or externally swept up or down. A third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep-gate output can be used to gate (burst) the generator on for swept bursts. The sweep-hold mode allows the generator to sweep to the stop frequency and remain there until released.

The accurate log/linear-sweep capability of the FG 507 plus the low distortion (0.25% over the audio range) make it ideally suited to audio testing.

FG 504

- **0.001 Hz to 40 MHz**
- **Three Basic Waveforms, Plus a Wide Range of Shaping With Variable Rise/Fall Times and Symmetry Controls**
- **Logarithmic or Linear Sweep**
- **Up to 30-V P-P Output**
- **Built-In Attenuator**
- **AM and FM**
- **Phase-Lock Mode**
- **External and Manual Trigger or Gate**
- **Counted Burst With DD 501**

The output of the FG 504 can be phase locked, gated, or triggered by a reference signal. This lets you convert from one waveform to another, such as pulses to sine waves, as well as adjusting phase relationships. Post-attenuator offset enables use of the full ±7.5 V offset range with small signals. The FG 504 output can be swept, or amplitude or frequency modulated by external signals. In addition, the FG 504 can supply internally generated linear- or logarithmic-swept frequencies of up to a 1000:1 range with convenient control of start and stop frequencies.

The FG 504 also provides trigger output, external voltage-control input, and sweep output.

FG 503

- **1.0 Hz to 3 MHz**
- **Three Waveforms**
- **VCF**

The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multiple steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency can be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V peak-to peak can be developed across a 50-Ω load (20 V peak-to-peak open circuit). Selectable offset up to 3.75 V dc across 50 Ω (7.5 V dc open circuit) is also featured.

FG 502

- **0.1 Hz to 11 MHz**
- **Five Waveforms**
- **VCF and Gated Burst**

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high-frequency range from 1 to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. VCF input permits the FG 502 to be used as a sweep generator or as an FM generator.

External-gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireless or radio remote-control equipment and in certain phases of the telephone industry.

FG 501A

- **0.002 Hz to 2 MHz**
- **30 V Peak-to-Peak, ±13-V Offset**
- **5 to 95% Variable Symmetry**
- **Trigger or Gate, ± Slope**
- **60-dB Step Attenuator**
- **≤0.25% Sine-Wave Distortion**
- **≤25-ns Rise/Fall**

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms—sine, square, triangle, ramp, and pulse—at output levels up to 30 V peak-to-peak with up to ±13 V of offset from a 50-Ω source. Waveform triggering and gating are provided with a variable phase control to permit up to ±90° of phase shift for generating haver-sines, sin pulses, and haver triangles. A step attenuator provides 60 dB of output signal attenuation in 20-dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse rise time is ≤25 ns. Audio sine-wave distortion is ≤0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low-distortion sine waves, the FG 501A is uniquely appropriate for applications requiring audio signals.

Also useful in audio applications is the 0- to 60-dB attenuator designed into the FG 501A.

The wide-range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

ORDERING INFORMATION

FG 5010 20-MHz Function Generator **$3,995**
Includes: Instruction manual (070-3467-01), instrument interfacing guide (070-4613-00), reference guide (070-3561-00).

FG 507 2-MHz Sweeping Function Generator **$2,275**
Includes: Instruction manual (070-2986-00).

FG 504 40-MHz Function Generator **$3,275**
Includes: Instruction manual (070-2655-00).

FG 504 T 40-MHz Function Generator **$3,695**
Includes: FG 504, TM 503A Mainframe, and 016-0195-03 Blank Panel.

FG 503 3-MHz Function Generator **$690**
Includes: Instruction manual (070-1727-01).

FG 502 11-MHz Function Generator **$1,110**
Includes: Instruction manual (070-1706-01).

FG 501A 2-MHz Function Generator **$940**
Includes: Instruction manual (070-2957-00).

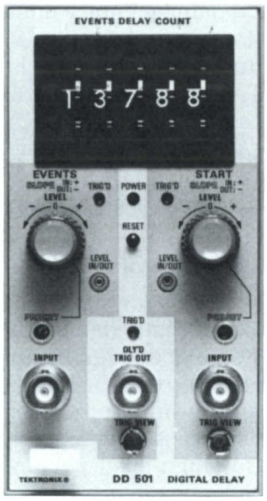
UTILITY SOFTWARE (FG 5010 only)

For TM 5000/4041—See System Support section for description.
Order 062-6958-01 **$150**

OPTIONAL ACCESSORIES (FG 5010 only)

Rear Interface Signal Cable Kit—Order 020-0701-00 **$40**
Service Kit—Order 067-1041-00 **$410**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.



DD 501 Digital Delay

DD 501

- **Digital Events Delay**
- **Delay to 99,999 Events**
- **Divide by N Up to 20 MHz**
- **Pulse Counting to 65 MHz**
- **Time Delay With External Clock**
- **Compatible with Most Attenuator Probes**

The DD 501 Digital Delay is an events-counting device that can be used with pulse, function, and clock generators in such applications as precise digital delay between two related events, divide-by-N frequency divider, precision gate generator, counted burst output from a gated pulse or frequency generator, etc.

Basically, the DD 501 has two modes of operation. In the gating mode, the DD 501 generates a gate that starts with the application of a start pulse and continues until a selected number of event pulses have occurred. It can be used for generating a counted burst of N pulses when used with a pulse generator capable of being gated. Tektronix generators capable of being gated by the DD 501 are the FG 501A, FG 502, FG 504, FG 507, FG 5010, PG 507, and PG 508.

In the delayed-trigger mode, the DD 501 generates a trigger pulse after the selected number of event pulses have occurred. Besides being used strictly for generating precision delays, the delayed-trigger mode can also be used as a frequency count-down divider for any frequency up to 65 MHz. In both modes, the desired number of events (from 0 to 99,999) is selected by front-panel thumbwheel switches.

Trigger slope and level controls for both the Start and Events inputs permit use with a wide variety of applied signals. Both inputs are compatible with Tektronix attenuator probes. In special applications, the trigger levels can be remotely set by application of analog voltages through the front-panel Level In/Out jacks.

CHARACTERISTICS

EVENTS DELAY

Count—10 to 99,999 events.
Maximum Count Rate—65 MHz.
Insertion Delay—30 ns or less from final event to trigger output pulse.
Recycle Time—50 ns or less.
Reset—Manually resets delay counter.

INPUT CHARACTERISTICS

All characteristics apply to both events and start inputs.
Input Impedance—1 MΩ, 20 pF.
Slope—Either + or −, selectable.
Sensitivity—85 mV p-p at 30 MHz.
Frequency Response—Up to 65 MHz at 120-mV sensitivity.
Minimum Detectable Pulse Width—5 ns.
Threshold Level Range—From −1.0 to +1.0 V (−10 to +10 V with 10X probe). Can be externally programmed or monitored at front-panel jacks.
Trigger View Out—Threshold-detector output, at least 0.5 V (200 Ω or less source impedance).
Events Triggered Light—Visual indication that events are being detected.
Start Triggered Light—Visual indication that delay is in progress.

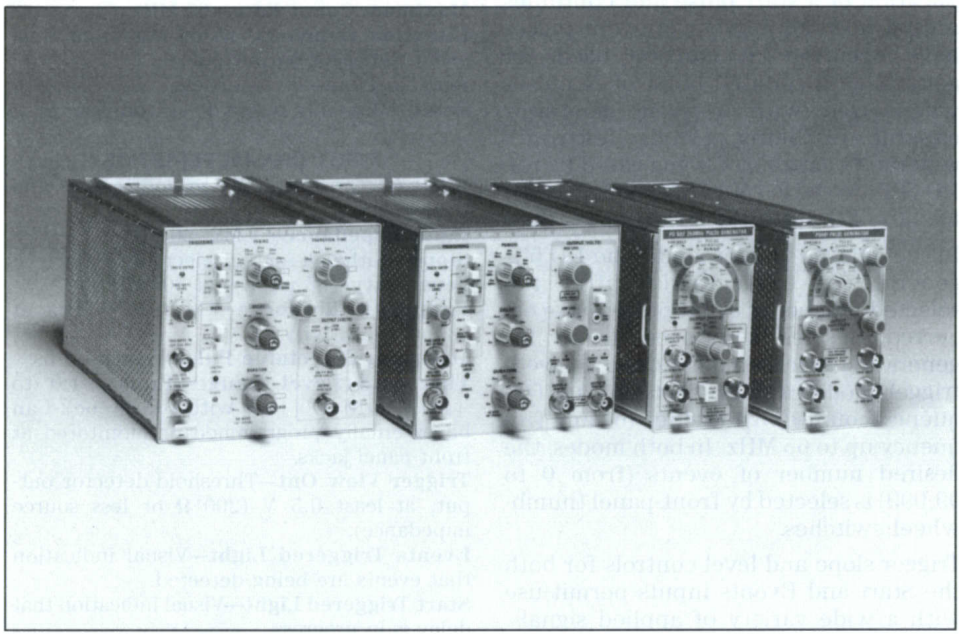
TRIGGER OUTPUT

Pulse Width—Width of events pulse plus 6 ns or less.
Voltage Swing—+0.8 V or less to at least +2.0 V with 3 TTL loads (≈5 mA).
Light—Indicates output trigger.

ORDERING INFORMATION

DD 501 Digital Delay **$1,930**
Includes: Instruction manual (070-1818-01).

PULSE GENERATORS



PRODUCT SUMMARY

The TM 500 Pulse-Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The PG 507 features complementary dual outputs making it ideally suited for digital applications. The dual-output feature is particularly useful when working with ECL circuits.

Similar to the PG 507 Pulse Generator is the 50-MHz PG 508, which features independently variable rise and fall times. The PG 508's high-level performance and versatility cover a broad range of test-and-measurement applications.

The accurate 50-Ω output impedances of the PG 507 and PG 508 deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50-MHz multipurpose generators are also designed for high-level performance on high-impedance circuits (MOS, HTL, and CMOS logic).

In 50-Ω systems, the PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families (TTL, DTL, and ECL) in repetition rates, amplitudes, and transition times.

The TM 500 Pulse Generators' wide range of features affords you ease of operation even on the most challenging test-and-measurement problems.

As with all TM 500 instruments, the pulse generators can be installed in TM 5000 mainframes and readily integrated into TM 5000 systems.

PULSE GENERATOR SELECTION GUIDE

Characteristic	PG 507	PG 508	PG 501	PG 502
Pulse Period (s)	≤20 n to ≥200 m (50 MHz to 5 Hz)			≤4 n to ≥100 m (250 MHz to 10 Hz)
Pulse Duration (s)	≤10 n to ≥100 m			≤2 n to ≥50 m
Duty Factor (s)	≥70% to 0.2 μ period, ≥50% at 20 n period			≥50%
Square-Wave Mode	✓	✓		✓
Pulse Delay (s)	≤10 n to ≥100 m*1		Fixed, 20 n	Fixed, 17 n
Double Pulse	✓	✓		
Transition Times (s)	fixed, ≤3.5 n, ≤4 n @ >5 V	≤5.5 n to ≥50 m, variable	Fixed, ≤3.5 n	Fixed, ≤1 n
Aberrations (% p-p)	≤5 +25 mV into 50 Ω	≤5 +50 mV into 50 Ω	±3.5 into 50 Ω	±5 (duration ≥5 ns)
Amplitude (V p-p from 50-Ω source impedance)	≥7.5, ±7.5-V window	≥10, ±10-V window	≥5	5, ±5-V window
Simultaneous Outputs	Complementary	No	Positive & negative	No
Pulse Coincidence	≤1 ns at 50% ampl.	NA	≤1 ns at 50% ampl.	NA
External Input Input Impedance (Ω)	1 M or 50	1 M or 50	50	50
Trigger Level (V) Sensitivity (mV p-p)	−3 to +3 80 to 10 MHz, 250 to 50 MHz		+1	+1
Trigger Output (50% square wave or follows external signal)	≥+2 V from 50 Ω, ≈35 ns before pulse (23 ns in square wave or external duration modes)		≥+2 V from 50 Ω, ≈8 ns before pulse	≥+2 V from 50 Ω, ≈10 ns before pulse
Price	$2,975	$2,360	$870	$3,100

*1 *Add 60 ns for delay from external trigger.*

PG 508

- **Independently Variable Rise and Fall Times to 5 ns**
- **20-V Output in a ±20-V Window to Impedance, 10 V into 50 Ω**
- **Normal or Complement Output**

The PG 508 is a versatile, general-purpose, 50-MHz pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real-world waveforms. This capability is particularly useful in research-and-development applications demanding versatility in rise and fall times, such as testing of amplifiers, slew-rate testing, comparator simulation, and logic-circuitry performance tests.

For example, controllable rise and fall times are extremely desirable when working with CMOS where logic power consumption increases with slower rise times. Also, variable rise and fall times are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the rise and fall times controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different rise and fall times, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508 is the capability of changing output amplitude while variable rise and fall times remain constant.

PG 507

- **Dual Outputs With Tracking Level Controls**
- **Normal or Complement Pulse Output on Both Channels**
- **15-V Output in a ±15-V Window Into High Impedance, 7.5 V Into 50 Ω**
- **3.5-ns Rise/Fall Times**

The PG 507 is a high-performance, 50-MHz pulse generator designed specifically for logic-design applications.

The PG 507 features complementary dual outputs that greatly increase its applicability in logic-design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite-phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and simultaneous positive mode (Channel A positive going, Channel B output positive going).

In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic-design or control applications requiring simultaneous signals.

PG 502

- **10 Hz to 250 MHz**
- **1-ns Rise Time**
- **5-V Output ±5-V Window**
- **Independent Pulse Top and Bottom Level Controls**
- **Selectable Internal Reverse Termination**
- **Manual Trigger Button**

The PG 502 features fast rise and fall times, independent top and bottom pulse levels, and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

PG 501

- **5 Hz to 50 MHz**
- **Simultaneous Plus and Minus Outputs**
- **5 V and 3.5 ns into 50 Ω**
- **Independent Period and Duration Controls**
- **Trigger Out**

The PG 501 is a 50-MHz Pulse Generator featuring simultaneous plus and minus outputs, a wide range of pulse-period durations and duty factors, trigger output, and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

50Ω Precision Coaxial Cable
For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3-ft, 50-Ω coaxial cable into a 50-Ω load.

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or a complete train of events with instruments that do not have a manual trigger button or where a remote-operation capability is desired, such as with some oscilloscopes and the PG 501.

The internal trigger-generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally 2 ms in width and 3 V in amplitude (from 50 Ω) with rapid rise and fall times.

ORDERING INFORMATION

PG 508 50-MHz Pulse Generator **$2,360**
Includes: Instruction manual (070-2044-01).
PG 508T 50-MHz Pulse Generator **$2,780**
Includes: PG 508, TM 503A Mainframe, and 016-0195-03 Blank Panel.
For counted burst order the DD 501 Digital Delay **$1,930**
Suggested 10-in. BNC 50-Ω cable (2 required) for interconnecting PG 508 and DD 501
Order 012-0208-00 **$28**
PG 507 50-MHz Pulse Generator **$2,975**
Includes: Instruction manual (070-2962-00).
PG 502 250-MHz Pulse Generator **$3,100**
Includes: Instruction manual (070-1598-01).
PG 501 50-MHz Pulse Generator **$870**
Includes: Instruction manual (070-1361-01).

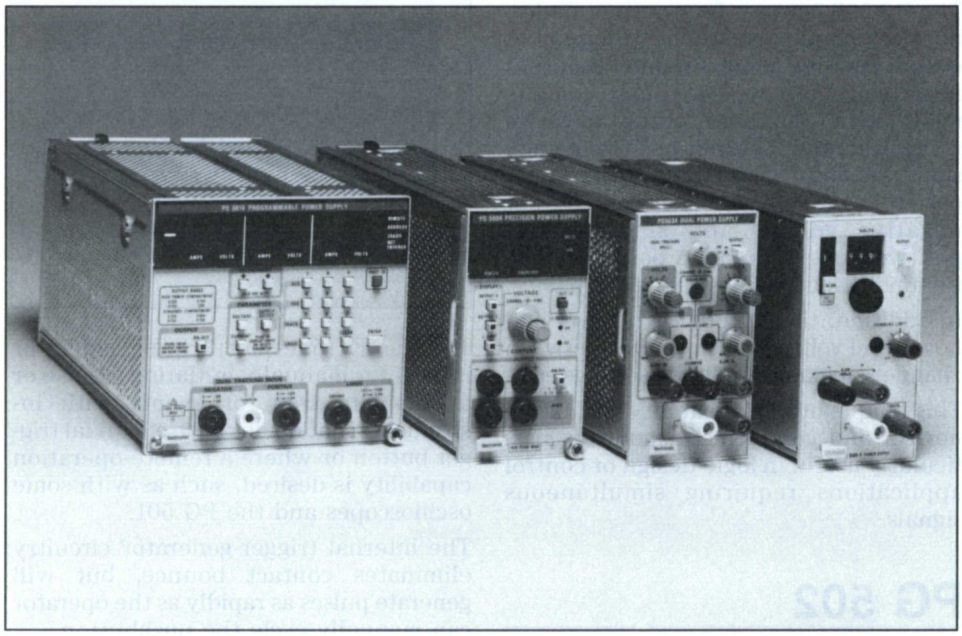
RECOMMENDED PROBES

See Accessories section.
P6062B—1X/10X, dc to 100 MHz. **$175**
P6108A—10X, dc to 100 MHz. **$75**
P6122—10X, dc to 100 MHz. **$58**

OPTIONAL ACCESSORIES

50-Ω Cable Order 012-0482-00 **$28**
Trigger Generator—
Order 016-0597-00 **$210**

POWER SUPPLIES



PRODUCT SUMMARY

Design engineers require power supplies that are flexible enough to meet their needs...and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench. To ensure versatility and convenience in your test system, the TM 5000/TM 500 power supplies can be rear-interfaced with other instruments to reduce front-panel clutter while providing capabilities not otherwise available. For example, the output level can be monitored via the rear interface by a companion TM 5000/TM 500 digital multimeter without the need for extra cabling at the front of the instrument. Remote sensing terminals available at the rear interface allow sensing of the applied voltage at the load, thereby minimizing the effects of loading on the supply.

POWER SUPPLIES SELECTION GUIDE

Characteristic	PS 501-1		PS 503A		PS 5004	PS 5010	
Supplies (V)	0 to 20	+5	+ and −20	+5	0 to 20	+ and −32	Logic
Isolation (V dc +peak ac)	350	gnd ref	350	gnd ref	42	150 front panel, 42 rear inter.	gnd ref
Current Limit (A) High-Power Compartment / Standard	<40 m–400 m	1	100 m–1 / 40 m–400 m	1	0–300 m	50 m to 0.760*1 / 50 m to 400 m*1	100 m–3
Voltage Mode Overall Accuracy (total effect)					±(0.01% +500 μV)	±(0.5% + 20 mA)	±50 mV
Source Effect (line regulation)	5 mV	50 mV	5 mV	250 mV	0.005%	±(0.1%+2 mV)	1 mV
Load Effect (load regulation) (V change for A change in load current)	1 m for 400 m	100 m for 1	3 m for 1	100 m for 1	500 μ for 300 m	10 m for 1; 1 m for 1 with remote sensing	
Temperature Coefficient (Typical)	<0.01%/°C	—	<0.025%/°C	—	≤(30 ppm +100 μV)/°C	<(0.01% +0.1 mV)/°C	<500 μV/°C
Resolution (step size) (V)	1.6 m	—	50 m		500 μ	10 m to 10; 100 m above 10.1	10 m
PARD (mV) (periodic and random deviations)	0.5 p-p; 0.1 RMS	5 p-p	3 p-p	5 p-p	≤3 p-p	10 p-p; 1 RMS	10 p-p; 2 RMS
Curent Mode	Current limit		Current limit		See individual instrument descriptions.		
Display	See individual instrument descriptions.						
Prices	$720		$770		$1,850		$3,050

Notes: 1. All supplies feature remote sensing at the rear interface.
2. All units have Output On/Off controls.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

PS 5010

GPIB IEEE-488 The PS 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- **Dual Floating Supplies 0 to 32 V, to 0.75 A (1.6 A to 15 V)**
- **Logic Supply +4.5 to 5.5 V, to 3 A**
- **0.5% Accuracy**
- **Programmable Current Limits**
- **Three Independent Digital Displays**
- **Automatic Crossover**

The PS 5010 Programmable Power Supply provides a complete and rapid high-performance solution for many system power-supply applications. Its three supplies provide the most commonly used voltages, and the three digital displays automatically indicate all six voltage- and current-limit parameters. Automatic crossover from voltage to current limit and a powerful set of GPIB status reporting messages allow the user to be constantly aware of the PS 5010's status.

The PS 5010's dual floating supply provides 0 to +32 V and 0 to −32 V, both with respect to a common front-panel terminal. Or 0 to 64 V across the terminals of both supplies together—with current up to 0.75 A throughout the total voltage range and 1.6 A below 15 V. The logic supply provides +4.5 to +5.5 V with respect to ground, with current to 3 A. The user can program the outputs on and off, and can lock out the front-panel controls with GPIB commands.

OTHER CHARACTERISTICS

POSITIVE AND NEGATIVE FLOATING SUPPLIES

Constant Current Mode

Range—50 mA to 0.75 A (1.60 A at 15 V and below) in high-power compartment; 50 mA to 400 mA (0.750 A at 15 V and below) in two standard-power compartments.

Overall Accuracy—±(5% +20 mA) Source Effect: ±1 mA line regulation. Load Effect: ±10 mA. Output impedance is typically 5 kΩ shunted by 20 μF.

PARD (Ripple and Noise)—10 mA p-p, 20 Hz to 20 MHz.

Resolution—50 mA ±15 mA.

Change Response Time—20 ms up or down.

LOGIC SUPPLY

Constant Current Mode

Range—100 mA to 3.0 A (Foldback characteristic below 4.5 V, maximum short circuit current is <1.5 A).

Overall Accuracy—±(5% +20 mA).

Resolution—100 mA ±30 mA.

Scaled Output—10 mA = 1 mV ±(2% +2 mV) available at rear interface (not ground referenced).

Overvoltage Protection—SCR crowbar typically trips at 6 to 7 V.

Power Consumption—250 V A maximum in high power compartment, 200 V A in standard compartment.

IEEE Standard 488-1978 Interface Function Subsets Implemented—Same as PS 5004.

Power Module Compatibility—The PS 5010 is not compatible with TM 500 mainframes.

PS 5004

GPIB IEEE-488 The PS 5004 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **0- to 20-V Floating Output**
- **0.01% Accuracy**
- **500 μV/0.1 mA Resolution**
- **Constant Voltage or Constant Current With Autocrossover**
- **Voltage- and/or Current-Monitoring Display**
- **Remote Sensing**

The single-width PS 5004 Precision Power Supply provides high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gauges and other transducer systems. Its 0- to 20-V output is covered with coarse and fine adjustments to provide rapid setability and ±500-μV resolution without the necessity of changing ranges. Setability resolution over the GPIB is also ±500 μV. The supply output is at the rear interface as from the front-panel terminals. Overall accuracy is ±0.01% ±2 mV.

The PS 5004 operates in either a constant-voltage or constant-current mode with autocrossover between the two. Front-panel annunciators indicate the mode at all times. The operating mode is also reported over the bus, and the PS 5004 can be programmed to assert SRQ when operating conditions cause it to change modes. The 4½-digit display shows actual output voltage, selected current limit, or actual output current. The actual output voltage is shown even when the PS 5004 is operating in the current-limited or unregulated mode. Display resolution is 1 mV or 0.1 mA.

The buffered high-impedance sense terminals allow proper regulation of the supply with up to 3 Ω of resistance in either of the sense leads.

OTHER CHARACTERISTICS

CONSTANT CURRENT MODE

Range—10 mA to 305 mA in 2.5 mA steps.

Overall Accuracy—±2% +5 mA.

Power Consumption—35 A V

IEEE Standard 488-1978 Interface Functions Subsets Implemented—SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

Power Module Compatibility—The PS 5004 is not compatible with TM 500 mainframes.

PS 503A

- **Independent + and − Controls**
- **Dual Tracking Voltage Control**
- **0 to ±20 V at 1 A (in High-Power Compartment)**
- **Fixed Output +5 V at 1 A**
- **Remote Resistance Programming**

The PS 503A provides dual floating variable ±20-V supplies, plus a fixed 5-V, 1-A supply. The PS 503A features superior tracking, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504, TM 506, RTM 506, or TM 5006 mainframe, the PS 503A can provide up to 1 A from both of the ±20-V supplies. A 0- to 40-V variable supply with up to 1 A of current can be configured by grounding one of the two outside terminals of the variable supplies. The two variable supplies can be set individually, then varied in a tracked mode with a single control. In addition, the plus and minus floating outputs can be programmed remotely, by either voltage programming or resistance programming via the rear interface.

PS 501-1

- **Floating Output, 0 to 20 V**
- **0 to 400 mA**
- **Precise Regulation**
- **Low Ripple and Noise**
- **Fixed Output +5 V at 1 A**
- **3½-Digit Ten-Turn Dial**

The PS 501-1 supplies 0 to 20 V (floating) and adjustable current limiting to 400 mA, with constant-current operation above the limit setting. The PS 501-1 features precise regulation and better than 2-mV resolution over its voltage range. A multiturn dial with mechanical digital readout provides accurate setting of the output voltage. A fixed +5-V supply provides up to 1 A.

ORDERING INFORMATION

PS 5010 Power Supply **$3,050**
Includes: Instruction manual (070-3391-00); instrument interfacing guide (070-4610-00); reference guide (070-3402-00).

PS5004 Precision Power Supply **$1,850**
Includes: Instruction manual (070-4442-00); instrument interfacing guide (070-4789-00); reference guide (070-4596-00).

PS 503A Power Supply **$770**
Includes: Instruction manual (070-1834-01).

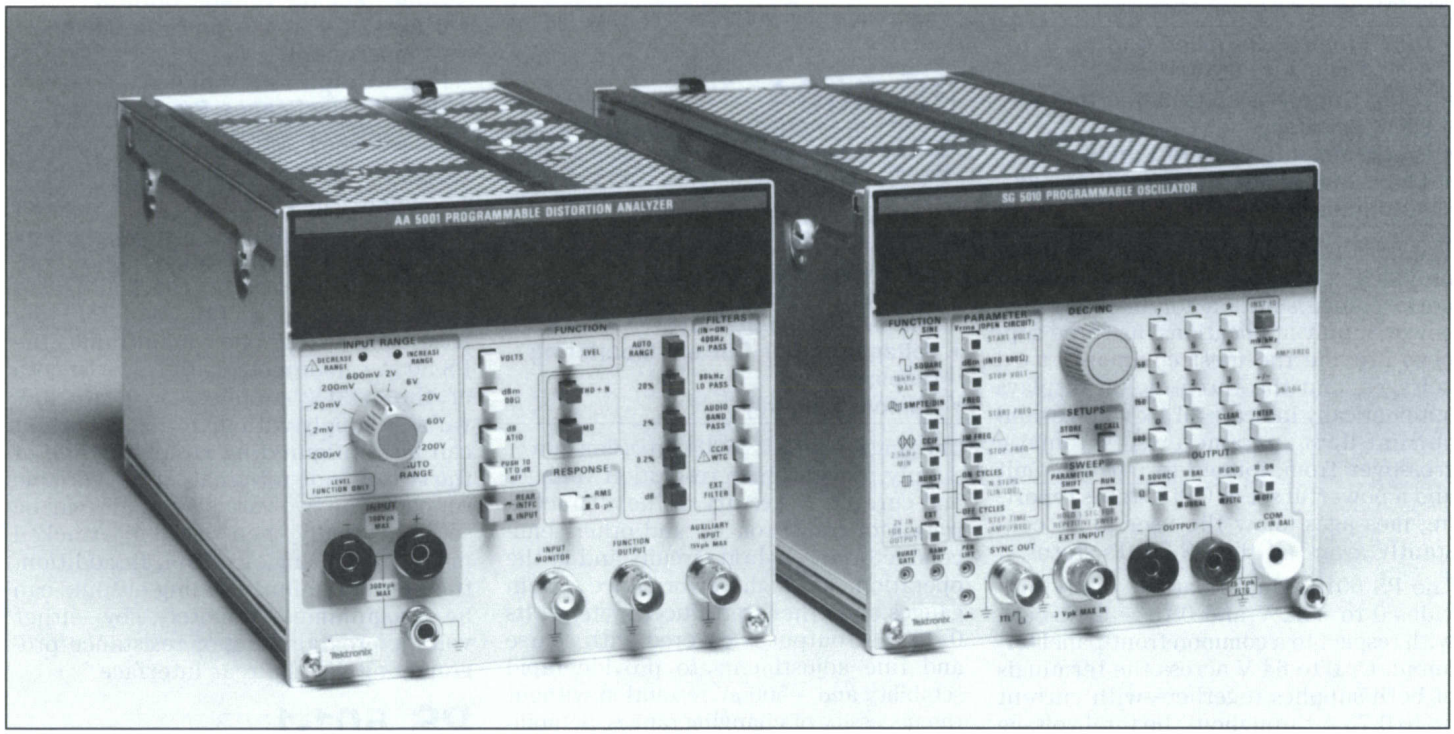
PS 501-1 Power Supply **$720**
Includes: Instruction manual (070-1301-02).

UTILITY SOFTWARE (PS 5010/PS 5004 only)

See System Support section for description.

For TM 5000/4041—
Order 062-6958-01 **$150**

AUDIO TEST SYSTEM



SG 5010/AA 5001

GPIB IEEE-488

The SG 5010 and AA 5001 comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **Fast, Accurate, Repeatable Measurements**
- **Easy to Use, Minimizes Training Needs**
- **Automatic Low-Cost Documentation of Test Results**

AUTOMATED AUDIO TEST SYSTEM

Advantages

Tektronix SG 5010 and AA 5001 programmable instruments in a computer-controlled test system will make critical audio measurements consistently, accurately, and in two to four seconds each. Even complex tests can be made by technically unskilled operators since the procedures are controlled by software in the controller. In addition, permanent graphic or tabular records of test results can be produced at very low cost.

An SG 5010/AA 5001-based system will automatically perform such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound-level meters). With the Option 02 capability of the AA 5001, noise measurements can be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal necessary for dynamic headroom tests per IHF A202.

A basic automated system consists of the SG 5010 Programmable Oscillator, the AA 5001 Programmable Distortion Analyzer, and an IEEE Standard 488 controller such as the Tektronix 4041 System Controller. Frequency counters, signal switchers, interface devices, disc storage, and hard copy units or plotters can be optionally added to the system.

The MP 2902 is a measurement package offering a total solution to your audio measurement requirements. It includes an automatic test program generator that dramatically reduces software-development time and allows program development by nonprogrammers. See Measurement Packages section.

Other Measurement Capabilities

Features and flexibility of the SG 5010 and AA 5001 permit a variety of other measurements to be easily automated. SMPTE-like IMD measurements can be made at a variety of lower frequencies and any value of upper frequency, and at 1:1 amplitude ratios in addition to the standard 4:1 ratio. A CCIF test with the frequencies selected near the upper band limit of the device under test has been shown to be a very effective and simple-to-implement test for transient or dynamic intermodulation (TIM and DIM). Burst signals of any desired duty cycle can be generated for IHF dynamic headroom measurements and to test compressors and limiters; the between-bursts level can be selected as Off or 20 dB below the burst level. Power measurements are made by a controller computation from a voltage measurement across a known load resistance. SINAD measurements of sensitivity of FM communications receivers are a standard capability of the AA 5001 plus an appropriate RF signal generator. The SG 5010 features an amplifier mode in which an external signal can be converted to the high-level, multiple-impedance, balanced and floating capability of the SG 5010 output circuitry. Fully program-selectable filters in the AA 5001 allow various choices of bandwidth for distortion measurements and weighting for noise measurements, or rejection of interfering signals. Phase measurements can be added to the system by use of the DC 5009 or DC 5010 Universal Counter Timer.

CHARACTERISTICS (SYSTEM)

HARMONIC DISTORTION FUNCTION

Measurement Settling Time—Typically ≤2.5 s above 100 Hz, increasing by 1 s/octave below 100 Hz.

Residual THD + N—V_{in} ≥250 mV, RMS response, all distortion, noise, and nulling resources combined. 20 Hz to 20 kHz ≤0.0032% (−90 dB) with 80-kHz filter. 10 Hz to 100 kHz ≤0.01% (−80 dB) no filters.

INTERMODULATION DISTORTION FUNCTION

Measurement Settling Time—Typically ≤2 s.

Residual IMD—V_{in} ≥250 mV, RMS response.

SMPTE and DIN Tests— ≤0.0032% (−90 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 ratio.

CCIF Difference Frequency Test— ≤0.0018% (−95 dB) with 14 and 15 kHz.

LEVEL FUNCTION

Measurement Settling Time—Typically ≤2 s.

Flatness— ±0.1 dB 20 Hz to 20 kHz.

CHARACTERISTICS (SG 5010)

AVAILABLE FUNCTIONS

Sine wave, square wave, SMPTE/DIN 4:1, SMPTE DIN 1:1, CCIF, Sine-Wave Burst, IHF Burst (±20 dB or Off between bursts), External Input (Amplifier Mode).

FREQUENCY RANGE AND ACCURACY

Sine Wave, Sine-Wave Burst

SMPTE/DIN: 10 Hz to 163.80 kHz ±0.01%.

CCIF Center Frequency: 2.500 to 163.80 kHz ±0.01%.

Square Wave: 10 Hz to 16.380 kHz ±0.01%.

Resolution in Above Functions

10.00 to 163.80 Hz: 0.01 Hz. 163.9 Hz to 1.6380 kHz: 0.1 Hz. 1.639 to 16.380 kHz: 1.0 Hz. 16.39 to 163.80 kHz: 10.0 Hz.

SMPTE Lower Tone, CCIF Offset From Center Frequency—Selectable From: 40, 50, 60, 80, 100, 125, 250, 500 Hz, all ±2%.

Sine Distortion (Load ≥600Ω, THD Including 2nd Through 5th Harmonics)— 20 Hz to 20 kHz: 0.001% (−100 dB). 20 to 50 kHz: 0.0032% (−90 dB). 10 to 20 Hz and 50 to 100 kHz: 0.01% (−80 dB). 100 to 163.8 kHz: 0.032% (−70 dB) any individual harmonic.

SMPTE, DIN, or CCIF Distortion—See System Specifications.

Sine Flatness—20 Hz to 20 kHz: 0.05 dB. 10 Hz to 163.8 kHz: 0.2 dB.

Square-Wave Rise Time—1.5 μs ±10%.

Burst Range—1 to 65535 cycles On. 1 to 65535 cycles Off. Off Level either −20 dB or zero. All switching at sine-wave zero crossing. Triggered, gated, or free-running burst modes available.

OUTPUT LEVEL RANGE AND ACCURACY

Balanced—Into Open Circuit: 200 μV to 21.2 V RMS. Into 600 Ω: −72.45 to +28.05 dBm.*1

Unbalanced—Into Open Circuit: 200 μV to 21.2 V RMS. Into 600 Ω: −72.45 to +22.05 dBm.*1

Resolution—0.05 dB in dBm mode, 0.25% or better in volts mode.

Level Accuracy (Sine Wave)—20 Hz to 20 kHz ±2% (0.2 dB). 10 Hz to 163.8 kHz ±3 (0.3 dB).

*1 *R_s=50 Ω. For R_s=150 Ω, subtract 1.25 dBm; for R_s=600 Ω, subtract 5.35 dBm.*

OUTPUT IMPEDANCE AND CONFIGURATION

50 Ω ±3%, 150 Ω ±2%, or 600 Ω ±1%, balanced or unbalanced, floating or grounded.

EXTERNAL INPUT

A floating single-ended input is provided for accessing the variable-gain stage and high-level output amplifier, enabling the use of custom test signals. Input impedance is 20 kΩ; a 2-V RMS input (2.83 V peak maximum) provides a calibrated output.

SYNC OUTPUT

A ground referenced TTL-compatible signal is provided that allows stable oscilloscope display of all functions. In sine- and square-wave modes, the output is at the signal frequency. In the IM modes, the sync output is at the lower or offset frequency. In both burst modes, the sync signal follows the burst envelope.

SWEEP MODE

Linear or logarithmic sweep of amplitude or frequency in any function. Sweep is composed of discrete steps. The following sweep functions are programmable via GPIB or from the front panel: swept parameter (frequency or amplitude), linear or log sweep, number of steps up to 99, time per step from 0.1 to 25 s, start frequency or voltage, and stop frequency or voltage. Start and stop frequencies or voltages can be anywhere within the range of the generator, and sweep direction can be upward or downward. Pen lift and ramp outputs are available for interface to an analog plotter.

STORED SETUPS

Ten different complete front-panel setups can be stored in the nonvolatile internal memory and recalled from front-panel pushbuttons or via the GPIB. Additionally, the front-panel settings at power down are retained and used at power up.

PROGRAMMABILITY

All functions, parameters, and modes can be controlled over the GPIB using simple English-like commands. All settings can be interrogated, with the resulting response usable as a command to return the instrument to that setting (Learn mode). The GPIB address can be displayed and changed from the front panel.

GPIB Interface Function Subsets Implemented—SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

CHARACTERISTICS (AA 5001)

HARMONIC DISTORTION FUNCTION

Fundamental Frequency Range—10 Hz to 100 kHz, automatically tuned to input frequency.
Distortion Ranges—Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).
Accuracy—20 Hz to 20 kHz is ±1 dB. 10 Hz to 100 kHz is +1, −2 dB. (Accuracy is limited by residual THD + N and filter selection.)
Fundamental Rejection—At least 10 dB below specified residual THD + N or actual signal THD, whichever is greater.
Minimum Input Level—60 mV (−22 dBm).

LEVEL FUNCTION

Autoranging digital voltmeter displays input-signal level in volts, dBm, or dB ratios.
Modes—Volts, dBm (600 Ω), or dB ratio with push-to-set 0 dB reference.
Level Ranges—200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy

Frequency	Volts	dBm or dB Ratio
20 Hz to 20 kHz	±2% ±1 count	±0.3 dB*1 +0.5% of reading
10 Hz to 100 kHz	±4% ±2 counts	±0.5 dB*1 +0.5 % of reading

*1 *V_{in} ≥100 μV, level ranging indicators extinguished. ±0.2 dB at 1 kHz only. Flatness is 0.1 dB, 20 Hz to 20 kHz, and ±0.3 dB, 10 Hz to 100 kHz.*

Bandwidth—≥300 kHz.
Residual Noise—
≤3 μV (−108 dBm) with 80-kHz and 400-Hz filters, RMS response.
≤1.5 μV (−114 dBm) with "A" weighting filter, RMS response (standard instrument only).
≤5 μV (−104 dBm) with CCIR weighting filter, quasi-peak response (Option 02 instrument only).

INTERMODULATION DISTORTION FUNCTION

Fully automatic SMPTE, DIN, and CCIF difference tone measurements. Minimum input level 60 mV (−22 dBm). Accuracy ±1 dB.
SMPTE and DIN Tests—Lower Frequency Range: 50 to 500 Hz. Upper Frequency Range: Usable from 3 to 163.8 kHz. Level Ratio Range: 1:1 to 4:1 (lower:upper). Residual IMD: See System Specifications.
CCIF Difference Frequency Test—Frequency Range: Usable from 4 to 163.8 kHz. Difference Frequency Range: 80 Hz to 1 kHz. Residual IMD: See System Specifications.

ALL FUNCTIONS

Display—3½-digits resolution at ≈3 readings/s.
Detection—Average or true RMS for waveforms with crest factors ≤3. Option 02 replaces average detector with quasi-peak detector complying with CCIR Recommendation 468-2 and DIN 45405.
Filters—
400 Hz High Pass: −3 dB at 400 Hz ±5%; 18 dB/octave slope, at least 40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%; 18 dB/octave slope.
Audio Bandpass: −3 dB at 22.4 Hz and 22.4 kHz, both ±5%. Complies with CCIR Recommendation 468-2 and DIN 45405.
"A" Weighting: Meets specifications for Type one sound-level meters (ANSI S1.4, IEC Recommendation 179). Option 02 replaces "A" weighting filter with CCIR weighting filter complying with CCIR Recommendation 468-2 and DIN 45405.
Ext: Allows connection of external filters.
Input Type—Balanced (full differential).
Input Impedance—100 kΩ ±2%, each side to ground.
Maximum Input—300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.
Common-Mode Rejection—≥ 50 dB at 50 or 60 Hz. Typically ≥40 dB to 300 kHz.

PROGRAMMABILITY

Function (Level or THD or IMD). Level Mode (Volts or dBm). Input Level and Distortion Ranges (Auto-range or default to range selected by front-panel switches).
Detector Type (RMS or AVG; or RMS or Q-PK on Option 02).
Filter Selection (400-Hz Hi Pass, 80-kHz Low Pass, 22.4 Hz to 22.4 kHz Band-Pass, "A" Weight (or CCIR WTG on Option 02, Ext Filter).
GPIB Interface Function Subsets Implemented—SH1, AH1, T6, L4, SR1, RL1, PP0 , DC1, DT0 , C0.

FRONT-PANEL SIGNALS

Input Monitor—Provides constant-amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.
Function Output—Provides a scaled sample of selected function signal. Output Voltage: 1 V RMS ±3% for 1000 count display. Source Impedance: 1 kΩ ±5%.
Auxiliary Input—Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR-INTERFACE SIGNALS

Duplicates of all front-panel inputs and outputs are provided to allow external filter connections or oscilloscope monitoring within same mainframe without exposed cables. Detector outputs with specified scale factors also available to drive analog chart recorders, storage oscilloscopes, or similar devices.

ORDERING INFORMATION

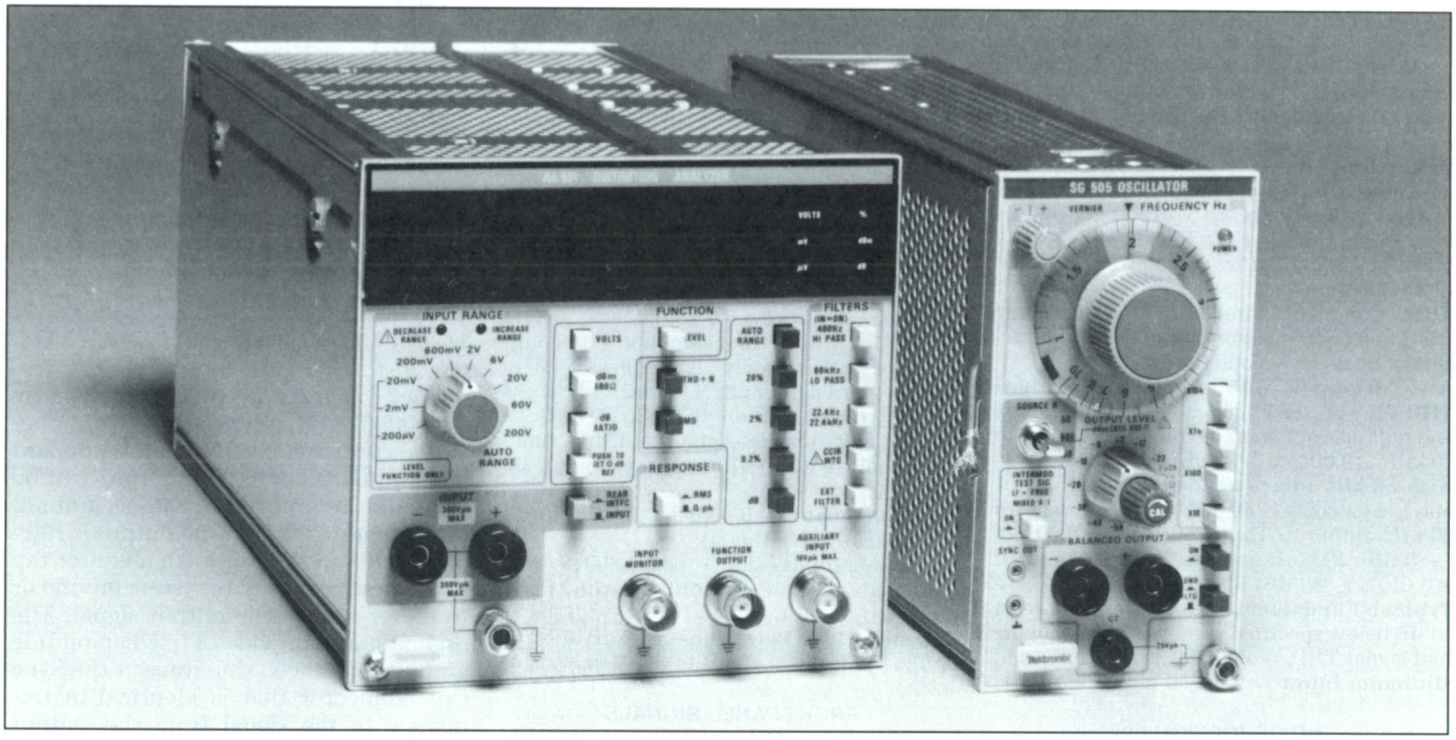
SG 5010 Programmable Oscillator **$4,195**
Includes: Instruction manual (070-4331-00); instrument interface guide (070-4790-00); reference guide (070-4330-00).
AA 5001
Programmable Distortion Analyzer **$3,450**
Includes: Instruction manual (070-4598-01); instrument interface guide (070-4788-00); reference guide (070-4597-00).
Option 02—(AA 5001 only)
CCIR/DIN. **+$410**

SOFTWARE

See System Support section for description.
Audio Test Program Generator Software—Order S45F902 **$300**
Utility Software—For TM 5000/4041. Order 062-6958-01 **$150**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

DISTORTION ANALYZERS



AA 501A

- **Fully Automatic: No Level Setting, Tuning, or Nulling**
- **Level, Total Harmonic Distortion, and dB Ratio Measurements**
- **Total System Harmonic Distortion Plus Noise (THD + N) <0.0025%**
- **≤3.0-μV Residual Noise**
- **Digital Readout Plus Analog-Like "Bar Graph" for Peaking and Nulling**
- **IMD to SMPTE, DIN, and CCIF (Option 01)**

The AA 501A Distortion Analyzer provides completely automatic measurement of level, total harmonic distortion plus noise (THD+N), and (with Option 01) Inter-modulation Distortion. Automatic set level, automatic tuning, automatic nulling of the fundamental, and autoranging of the display all combine to permit completely hands-off operation once the mode is selected. Just apply the signal of interest and read the 3-digit display. A novel analog like bar graph simulates an analog meter to assist in peaking and nulling of applied signals.

With Option 01, intermodulation-distortion measurements can be made to any of the three common standards: SMPTE, DIN, or CCIF. Internal circuitry automatically identifies the signal being used and selects the proper filtering circuits to perform the measurement.

dB-ratio measurements can be referenced either to 774.6 mV (1 mW in 600 Ω) or to a selected applied signal. The 0-dB reference memory remembers the selected level, and all subsequent measurements are referenced to that level.

The AA 501A allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The fundamental frequency range is 10 Hz to 100 kHz, with harmonics measured out to 300 kHz.

Any one of four built-in frequency-weighting filters can be switched into the signal paths for preconditioning of the signal to be measured. Provision is also made to permit the use of a user-selected filter. A dc level, which is a function of the display readout, is available at the rear panel of the AA 501A.

An Input-Monitor connector and a Function-Output connector are provided to permit oscilloscope display of the input signal or the result of the filter in the THD+N measurement.

The Option 02 version of the AA 501A is especially designed for use in accordance with CCIR recommendation 468-2 and DIN 45405 (typically used in Europe). In the Option 02 version, the 30-kHz filter and the "A" weighting filter of the standard unit are replaced by a 22.4-Hz-to-22.4-kHz filter and a CCIR-weighting filter, respectively, and the average-responding detection circuit is replaced by a quasi-peak detection circuit. The Option 02 also contains the intermod measurement capability of the Option 01.

The AA 501A Distortion Analyzer and the SG 505 Oscillator were designed to be used together as the heart of a state-of-the-art audio-analysis system. Used together, the two provide total system harmonic distortion of 0.0025% or less.

It should be noted that the automatic frequency tuning of the AA 501A does not depend upon the manual tuning of a companion oscillator. The AA 501A will automatically tune itself to its input signal whether the signal originates from an SG 505 alongside it in a TM 500 mainframe, or from some other signal source miles away.

CHARACTERISTICS

The following characteristics are common to the standard AA 501A, Option 01, and Option 02 unless otherwise noted:

HARMONIC DISTORTION FUNCTION

Fundamental Frequency Range—10 Hz to 100 kHz automatically tuned to input frequency.
Distortion Ranges—Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).
Accuracy (Readings ≥4% of Range)—20 Hz to 20 kHz ± 1 dB, 10 Hz to 100 kHz + 1, −3 dB. (Accuracy is limited by residual THD+N and filter selection.)
THD—Complete Automatic Total Harmonic Distortion (THD) measurements to specified accuracy in seven seconds or less.
AA 501A/SG 505 System Residual THD + N—V_{in} ≥250 mV, (all distortion, noise, and nulling error sources combined). 20 Hz to 20 kHz: ≤0.0025% (−92 dB) Average Response with 80-kHz filter (standard and Option 01 only). ≤0.0032% (−90 dB) RMS Response with 80-kHz filter. 10 Hz to 50 kHz: ≤0.0071% (−83 dB) RMS Response. 50 to 100 kHz: ≤0.010% (−80 dB) RMS Response.
Typical Fundamental Rejection—At least 10 dB below specified residual THD+N or actual signal THD, whichever is greater.
Minimum Input Level—60 mV (−22 dBm).

NOISE (OPTION 02)

Noise measurements to CCIR recommendation 468-2 and DIN 45405. True RMS or quasi-peak response. Total system THD + N = 0.0032% (90 dB) RMS response. Balanced input.

LEVEL FUNCTION

Autoranging digital voltmeter displays input-signal level in volts, dBm, or dB ratios.
Modes—Volts, dBm (600Ω), or dB ratio with push-to-set 0-dB reference.
Level Ranges—200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy*1

Frequency	Volts	dBm or dB Ratio
20 Hz to 20 kHz	±2%	±0.3 dB
10 Hz to 100 kHz*2	±4%	±0.5 dB

*1 *V_{in} ≥100 μV, level-ranging indicators extinguished.*
*2 *On the 200-μV range, accuracy above 50 kHz is +4%, −6% (+0.5 dB, −0.7 dB).*

Bandwidth—≥300 kHz.
Residual Noise—≤3.0 μV (−108 dBm) with 80-kHz and 400-Hz filters. ≤1.5 μV (−114 dBm) with "A" weighting filter.

INTERMODULATION DISTORTION FUNCTION (OPTION 01/02)

Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.
SMPTE and DIN Tests—Lower Frequency Range: 50 to 250 Hz. Upper Frequency Range: 3 to 100 kHz. Level Ratio Range: 1:1 to 5:1 (lower:upper). Residual IMD: ≤0.0025% (−92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.
CCIF Difference Frequency—Frequency Range: 4 to 100 kHz. Difference Frequency Range: 50 Hz to 1 kHz. Residual IMD: ≤0.0018% (−95 dB) with 14 and 15 kHz. Minimum Input Level: 60 mV (−22 dBm).
Accuracy—±1 dB.

ALL FUNCTIONS

Detection—Average or true RMS for waveforms with crest factors ≤3.
Filters
400 Hz High Pass: −3 dB at 400 Hz ±5%; at least −40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz 5%.
30 kHz Low Pass: −3 dB at 30 kHz ±5% (standard and Option 01 only). "A" Weighting: Meets specifications for Type 1 sound-level meters (ANSI S1.4, IEC Recommendation 179) (standard and Option 01 only). Ext: Allows connection of external filters. 22.4 Hz to 22.4 kHz: −3 dB ±5% (Option 02 only). CCIR WTG: CCIR Recommendation 468-2 and DIN 45405, functional only with Q-PK detector (Option 02 only).
Input Impedance—100 kΩ ±2%, each side to ground, fully differential.
Maximum Input—300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.
Common-Mode Rejection—≥50 dB at 50 or 60 Hz. Typically ≥40 dB to 300 kHz.

FRONT-PANEL SIGNALS

Input Monitor—Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.
Function Output—Provides a scaled sample of selected function signal (1000 count display =1 V RMS ±3%). Source Impedance: 1 kΩ ±5%.
Auxiliary Input—Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR-INTERFACE SIGNALS

Rear INTFC Input—Front-panel selected. Same as main Input except, maximum signal input is limited to 42 V peak, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion on performance.)
Monitor—Same as front-panel Input Monitor.
Function Output—Same as front-panel Function Output.
Auxiliary Input—Same as front-panel Auxiliary Input.
Converter Output—DC-output of selected response converter. 1 V ±5% for 1000-count display. Source Z: 500 Ω ±5%.
dB Output—DC-output of logarithmic dB converter. 10 mV ±5% per 1 dB of display. Source Z: 1 kΩ ±5%.

SG 505 /Option 01/Option 02

- **10-Hz to 100-kHz Sine Wave Output**
- **Ultra-Low Distortion: <0.0008% THD (Typically 0.0003%)**
- **Floating or Grounded Output**
- **600-Ω Source Impedance**
- **Vernier Frequency Control**
- **Fully Balanced Output (Option 02)**
- **Uncalibrated Output to +28 dBm (Option 02)**
- **Selectable Source Impedance (Option 02)**
- **Intermodulation Test Signal (Options 01 & 02)**

The SG 505 Oscillator generates an ultra-low distortion sine wave over the frequency range from 10 Hz to 100 kHz (<0.0008% THD, typically 0.0003% between 20 Hz and 20 kHz). In the standard and Option 01 units, the output can be floated or referenced to chassis ground. In the Option 02 unit, the output is fully balanced and floating with a center tap that can be attached to system ground or to either side of the output signal. The oscillator also provides a fixed amplitude ground-referenced sine wave at the Sync Out connector that is identical in frequency to the signal from the Output connector.

Option 01 adds an intermodulation test signal function. This signal consists of a selectable 60- or 250-Hz sine wave mixed with the selected frequency in a 4:1 amplitude ratio.

For communications and broadcast applications, Option 02 provides a fully balanced output of +22 to −68 dBm calibrated, into 600 Ω. A ten-position output-level control provides 10-dB/step calibrated attenuation. Uncalibrated outputs can range from +28 dBm (into 600 Ω from a 50-Ω source) to −78 dBm.

Option 02 has a front-panel switch that allows the selection of three different source resistances: 50 Ω for low-impedance applications (improves measurement accuracies on long cable runs and reduces loading effects), 150 Ω for matching microphone circuits, and 600 Ω for complying with audio/communication-industry standard and general-purpose applications.

Option 02 also includes the intermodulation test-signal capability of the Option 01.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

CHARACTERISTICS

MAIN OUTPUT

The following characteristics are common to the standard SG 505 and Option 01.

Frequency Range—10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least ±1% of frequency setting.

Calibrated Output—Selectable from +10 to −60 dBm into 600 Ω in eight 10-dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to < −10 dB from calibrated positon.

Amplitude Response—Level flatness ±0.1 dB from 10 Hz to 20 kHz (1-kHz ref); within 0.2 dB from 20 to 100 kHz (excluding >50 kHz on −60-dB output-level range).

Harmonic Distortion—<0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 to 20 Hz, and from 20 to 50 kHz; 0.0032% (−90 dB) THD from 50 to 100 kHz ($R_L \geq 600\ \Omega$).

Output Impedance—600 Ω ±2%; floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Maximum floating voltage ±30 V peak.

Maximum Output Voltage—At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or +12.2 dBm) into 600 Ω.

SYNC OUTPUT

Signal—200 mV RMS ±20% sine wave to 20 kHz, at least 120 mV RMS at 100 kHz.

Frequency—Same as main output.

Impedance—Nominally 1 kΩ, ground referenced and isolated from main output.

REAR INTERFACE SIGNALS

Buffered Main Output—Buffered version of actual output signals from front-panel connector. ≈300 Ω Output impedance.

Sync Output—Same as front-panel Sync Output except output impedance is ≈50 Ω.

OPTION 01 IM Test Signal

Selecting the IM Test Signal causes an LF sine wave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

LF Frequency—Internally selectable 60 Hz (±1 Hz) or 250 Hz (±3 Hz).

Main Output—Composite p-p output within 0.2 dB of normal oscillator mode output.

Residual IMD—Typically <0.0005% from 2.5 to 10 kHz.

Sync Output—LF signal component only, 200 mV RMS ±20%.

OPTION 02 Oscillator

MAIN OUTPUT

Calibrated Output—Selectable from +22 to −68 dBm into 600 Ω in ten 10-dB steps. Accurate to within 0.2 dB at +22 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB-step or 20-dB-step change. An uncalibrated control provides continuous variation from < −10 to +0.3 dB from calibrated position.

Harmonic Distortion—<0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 to 20 Hz, and from 20 to 50 kHz; 0.0056% (−85 dB) THD from 50 to 100 kHz ($R_L \geq 600\ \Omega$).

Output Impedance Selectable—600 Ω ±2%, 150 Ω ±2% or 50 Ω ±3% floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Impedance to CT is ½ the selected impedance. Maximum floating voltage ±25 V peak.

Maximum Output Voltage—At least 21 V RMS open circuit; 19.45 V RMS (+28 dBm) into 600 Ω from 50 Ω.

Balance—≤0.5% mismatch of output open-circuit voltages referenced to CT for f ≤20 kHz with output grounded.

ORDERING INFORMATION

AA 501A Distortion Analyzer **$2,525**
Includes: Instruction manual (070-2958-00).
SG 505 Oscillator **$890**
Includes: Cable assembly for sync output (175-1178-00); instruction manual (070-2823-00).

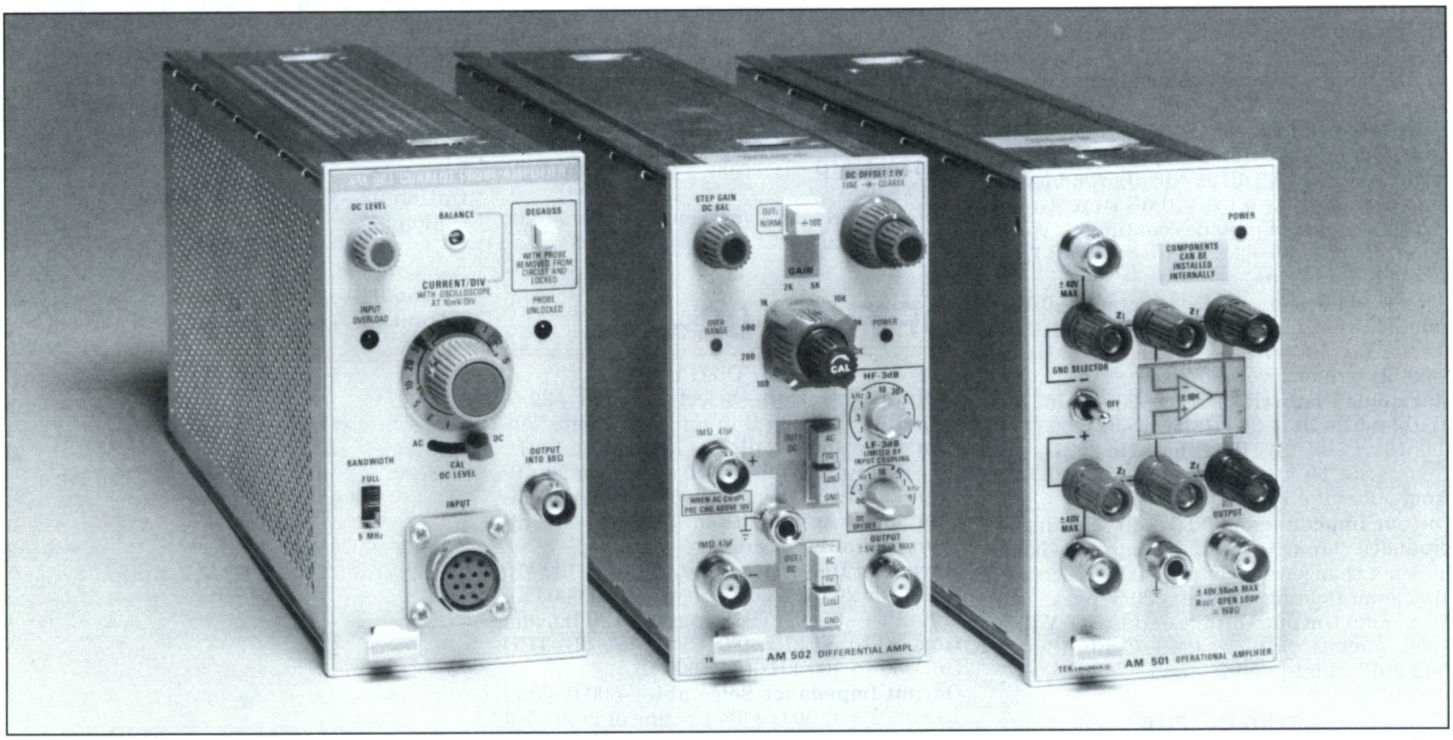
OPTIONS (AA 501A)

Option 01—Intermodulation Distortion. **+$750**
Option 02—CCIR/DIN (Includes Option 01). **+$1,150**

OPTIONS (SG 505)

Option 01—IM Test Signal **+$225**
Option 02—Oscillator (Includes Option 01). **+$730**

SIGNAL CONDITIONERS



PRODUCT SUMMARY

The TM 500 Signal Conditioners offer unique capabilities for solving electrical measurement-and-analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs including: preamplification of low-level signals, addition or removal of dc offset, integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V peak-to-peak).

The AM 503 is specifically designed to work with the A6302/A6303 Current Probes and incorporates a feature that limits the bandwidth to 5 MHz to eliminate transients or noise. An illuminated knob skirt indicates calibrated current per division.

The A6302/AM 503 and A6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power-supply measurements to medical applications. These probes use inductive coupling to minimize interference with the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset, and low-frequency and high-frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to 1 V. High-performance features of the AM 502 are a dc-to-1 MHz bandwidth and 100-dB common-mode-rejection ratio.

The AM 501 Operational Amplifier's output power (±40 V and ±50 mA across 800-Ω loads) is more than adequate for most electronic and electro-mechanical applications. This high-output unit has front-panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentiation, integration, summing, and impedance-transformation problems.

By combining an oscilloscope, such as the SC 504, with the A6303/AM 503 Current Probe Amplifier in a TM 500/TM 5000 mainframe, you will have a convenient and compact high-current amplification/measurement system.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

AM 503

- **Displays Current Signals on an Oscilloscope**
- **Current Range, Maximum Current, Bandwidth Determined by Probe**

The AM 503 Current-Probe Amplifier allows display of current on any oscilloscope having 10 mV/div sensitivity, 50-Ω or 1-MΩ input, and (for performance to full bandwidth) at least 100 MHz when using the A6302 or 50 MHz when using the A6303. The amplifier attenuator has 12 calibrated steps in a 1-2-5 sequence, and the knob-skirt is illuminated to indicate current per division.

CHARACTERISTICS

The AM 503 characteristics when used with the A6302 or A6303 Current Probes.

Maximum Input Current—20 A (dc + peak ac) for A6302. 100A (dc + peak ac) for A6303.

Maximum Voltage for Current Under Test (Bare Conductor)—500 V (dc + peak ac) for A6302. 700 V (dc + peak ac) for A6303.

Bandwidth (−3 dB)—DC to at least 50 MHz with A6302. DC to at least 15 MHz with A6303.

Rise Time (Full Bandwidth)—7 ns or less with A6302. 23 ns or less with A6303.

Deflection Factor—1 mA/div to 5 A/div for A6302. 20 mA/div to 50 A/div for A6303. In a 1-2-5 sequence for both probes.

Attenuator Accuracy—Within 3% of indicated Current/Div for both probes.

A6303 Current Probe

- **AC and DC Current Measurements to 100 A**
- **DC to 15 MHz Bandwidth**
- **Peak Pulse Measurements to 500 A**
- **AC or DC Coupling**
- **1.0-by-0.830-Inch Jaw Opening**
- **One-Hand Operation**

This clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the A6303 can easily be clamped to cables up to 0.830 inch. Other measurement parameters of the probe include: 100 A continuous and 500 A peak.

A6302 Current Probe

- **1-mA to 20-A Current Measurement Range**
- **50-A Peak Pulse Measurements**
- **DC to 50-MHz Bandwidth**

When an A6302 Current Probe is used with the AM 503 Current-Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A, not to exceed a product of 100 Aμs. The probe operates through inductive coupling with no electrical contact.

AM 502

- **1 to 100,000 Gain**
- **100-dB CMRR**
- **Selectable Upper and Lower −3 dB Points**
- **DC to 1 MHz Maximum Bandwidth**
- **Adjustable DC Offset**

The AM 502 Differential Amplifier features wide bandwidth, high CMRR, and selectable calibrated gain and filtering. Well-suited for general-purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity-gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

CHARACTERISTICS

AMPLIFIER

Gain—100 to 100,000; 1-2-5 sequence; accurate within 2%. 1X gain obtained by 100X attenuation.

HF −3 dB Point—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, Upper −3 dB point reduces to 500 kHz at 50 k gain; 250 kHz at 100 k gain.

LF −3 dB Point—Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits −3 dB point to 2 Hz or less.

Variable DC Offset—At least ±1 V.

Common-Mode Rejection Ratio—Normal Mode: At least 100 dB, dc to 50 kHz. ÷100 Mode: at least 50 dB, dc to 50 kHz.

INPUT

Input Gate Current—±100 pA for T ≤30°C.

Maximum Voltage Drift—100 μV/°C referred to input Normal mode.

Maximum Noise—≤25 μV (tangentially measured) referred to input Normal mode.

Maximum Input Voltage—Normal Mode DC Coupled: 15 V (dc + peak ac). ÷100 Mode DC Coupled: 350 V (dc + peak ac). AC Coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

Input R and C—1 MΩ paralleled by ≈47 pF. Input impedance can be increased to a FET input via a simple internal jumper change.

OUTPUT

Maximum Output—±5 V, ±20 mA, output resistance is 5 Ω or less.

Minimum Load Impedance—250 Ω

Over Range—Front-panel lamp indicates most over-range conditions.

AM 501

- **±40-V, 50-mA Output**
- **Open-Loop Gain 10,000**
- **50 V/μs Slew Rate**
- **Symmetrical Differential Design**

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification, impedance transformation, integration, differentiation, and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 modules.

CHARACTERISTICS

AMPLIFIER

Open Loop Gain—At least 10,000 at 60 Hz into 800-Ω load.

Unity Gain Bandwidth—At least 5 MHz into 800-Ω load.

Common-Mode Rejection Ratio—Typically >20,000 to 1 at 60 Hz for common-mode signals up to ±40 V.

Slew Rate—At least 50 V/μ s into an 800-Ω load.

INPUT

Input Bias Current—Typically <500 pA at 25°C, <2 nA at 50°C.

Drift—<100 μV/°C.

Noise—<10 μV RMS.

Maximum Differential Input Voltage—80 V.

OUTPUT

Voltage Range—At least ±40 V into 2 kΩ.

Current Limit—At least ±50 mA.

Open Loop Output R—≈150 Ω.

AM 501 Accessory Auxiliary Circuit Board Kit

The Auxiliary Circuit Board Kit attaches to the input and output terminals on the front of the AM 501 Operational Amplifier. The kit is a pc board that has six terminal studs for attachment to the amplifier's banana jacks and is approximately 2.5-inches square. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits.

ORDERING INFORMATION

AM 503 Current-Probe Amplifier **$1,185**
Includes: 50-Ω cable with BNC (012-0057-01); 50-Ω terminator (011-0049-01); instruction manual (070-2052-01).

AM 502 Differential Amplifier **$1,425**
Includes: Instruction manual (070-1582-01).

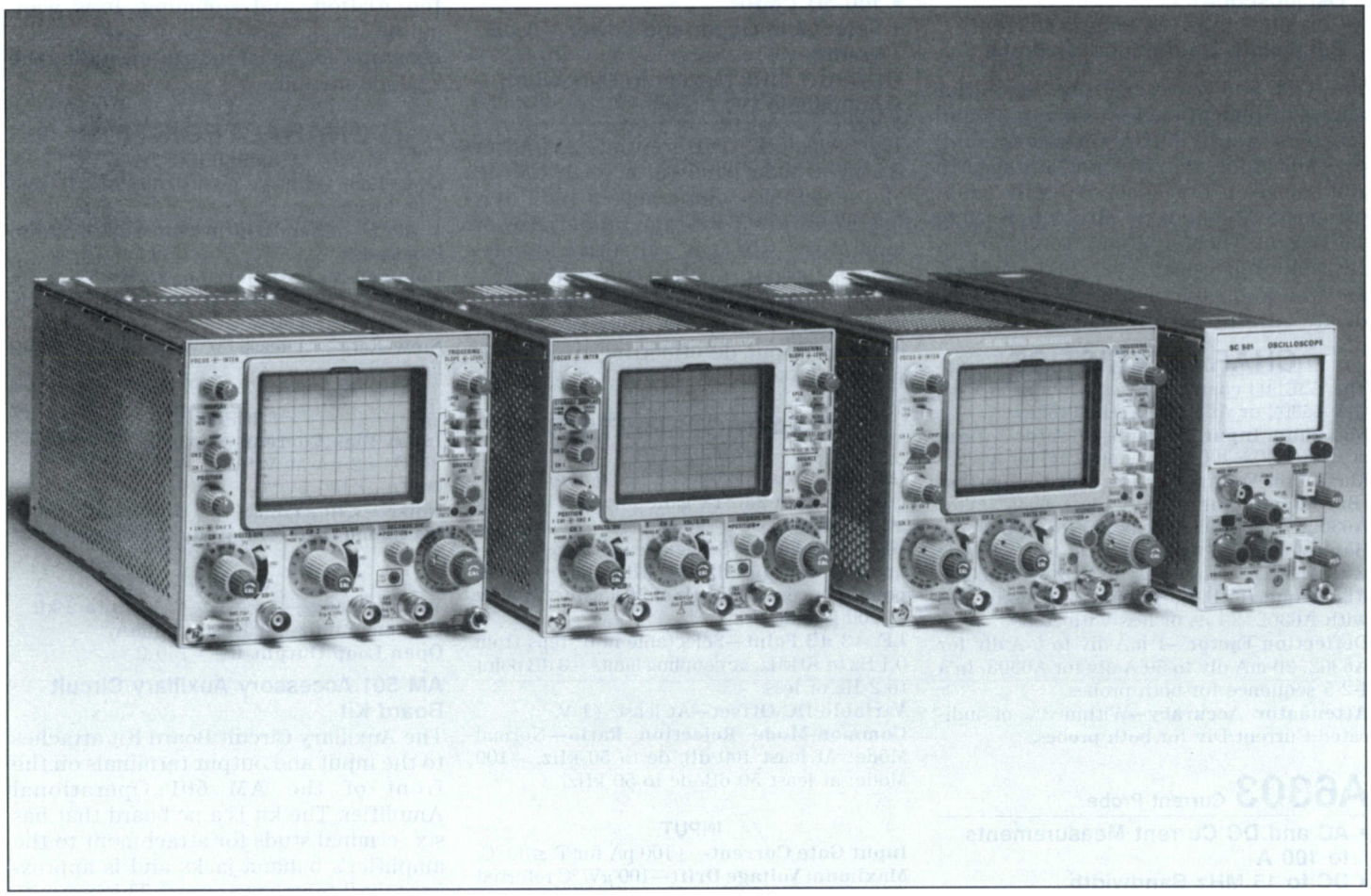
AM 501 Operational Amplifier **$840**
Includes: Instruction manual (070-1616-01).

A6303 Current Probe **$1,120**
Includes: Carrying case (016-0622-00); instruction manual (070-3906-01).

A6302 Current Probe **$595**
Includes: Five-inch ground lead (175-0124-01); three-inch ground lead (175-0263-01); two alligator clips (344-0046-00); instruction manual (070-3905-01).

Auxiliary Circuit Board Kit
Order 013-0146-00 **$27**

MODULAR OSCILLOSCOPES



PRODUCT SUMMARY

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronic test-and-measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop its line of modular instrumentation without including CRT-display capability.

Four choices of performance level and display size are available to add waveform display to the digital-measurement capability of modular digital multimeters and counters, ranging from the high-performance, dual-trace, 80-MHz SC 504 to the single-trace, single-width, 5-MHz SC 501. The 15-MHz SC 502 adds moderate dual-trace performance to the line, and the 10-MHz, dual-trace SC 503 adds CRT-storage capability.

All of the oscilloscopes feature automatic triggering, and the SC 504, SC 503, and SC 502 also provide trigger view and variable trigger holdoff. All of the oscilloscopes have provisions to permit instrument-to-instrument rear interfacing within a mainframe and to external devices of a test system.

With a compact TM 500 oscilloscope and a multicompartment mainframe, it is now possible to carry an oscilloscope and companion instruments to and from a test site in one convenient package.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

OSCILLOSCOPE SELECTION GUIDE

Application/Feature	SC 504	SC 503	SC 502	SC 501
Vertical Deflection*1				
HF Bandwidth (MHz) (Upper −3 dB point)	80	10	15	5
Rise Time (ns)	4.4	35	23	—
Step Response Aberrations	±4%	±2%, ≤3% p-p		—
AC-Coupled Low-Frequency Response (Hz)	≤10, 1, with 10X probe*1			≤2
Deflection Factors (V/div)	5 m to 10, 1-2-5 sequence; continuously variable between 11 calibrated steps	1 m to 20, 1-2-5 sequence; continuously variable between 4 calibrated steps		10 m, 100 m, 1 continuously variable
Accuracy	±2%	±3%	±2%	±3%
Input R&C (MΩ paralleled by pF)	1±1% ‖ ≈20		1±1% ‖ ≈47	
Max Input Voltage: (V dc+peak ac)	250	350	350	350
(V p-p @ ≤1 kHz)	500	700	700	
CMRR (CH1 minus CH2)	At least 50:1 at 1 MHz with same attenuator setting			NA
Channel Isolation	NA	2% or less to 10 MHz	2% or less to 15 MHz	NA
Displayed Noise	NA	≤0.2 mV p-p at 1 mV/div		NA
Calibrator (V)	0.6±1%, ≈1 kHz		0.6±1%, ≈twice power-line freq.	
Horizontal Deflection Sweep Rates (s/div)	0.2 to 50 n (21 steps, 1-2-5 seq.), X10 Mag to 5 n	2 to 0.5 μ (21 steps, 1-2-5 seq.), X10 Mag to 50 n	0.5 to 0.2 μ (20 steps, 1-2-5 sequence), X10 Mag to 20 n	1 μ to 100 m (decade steps)
Continuously Variable To	0.5 s/div	5 s/div	1.25 s/div	1 s/div
Sweep Rate Accuracy*2	±3%, 0.2 s to .50 ms/div; ±2%, 20 ms to 0.2 μs/div; ±3%, 0.1 μs to 50 ns/div	±4%, 2 s to 0.5 s/div; ±3%, 0.2 s to 5 μs/div; ±4%, 2 μs to 0.5 μs/div	±3%, all rates	±5%, all rates
X-Y Mode: Bandwidth (Hz)	DC to 2 M	DC to 500 k	DC to 2 M	DC to 100 k
Phase Diff.	3° at 50 kHz			—
Trigger Sensitivity (min. p-p signal)				
Coupling / Source (MHz)	DC to 30 / 30 to 80	DC to 5 / 5 to 10	DC to 5 / 5 to 15	DC to 5
DC / CH1, CH2 (div)	0.4, 60 mV / 1, 150 mV	0.4 / 1	0.4 / 1	0.4
Ext, Rear Interface	typ. 50 mV / 100 mV to 50 MHz	35 to 60 mV / 80 to 150 mV	60 mV / 150 mV	5 V
AC	Requirements increase below 50 Hz			NA
AC LF Rej.	Requirements increase below 10 kHz		Requirements increase below 5 kHz	NA
AC HF Rej.	Requirements increase above 50 kHz		NA	NA
Triggering Level Range	Ext ≥1.4 V	Ext ≥1.2 V, Int ≥6 div	Ext ≥1.2 V, Int ≥8 div	
CRT: Phosphor	GH (P31)	GX (P44)	GH (P31)	GH (P31)
Accelerating Potential	12 kV		12 kV	
Graticule	8×10 div (0.25 in./div) internal graticule lines)			6×10 div (0.2 in./div)
Recommended Probes	1X, P6101A; 10X, P6102A; 1X/10X, P6062B			
Prices	$3,960	$4,160	$2,840	$1,820

*1 *Optimum bandwidth, rise time, aberrations, and deflection-factor accuracy. Expect lower performance for other temperature ratings and attenuator settings.*

*2 *Accuracy at 15 to 35°C, X1 magnifier. Derate additional 1% for X10 magnifier on, and an additional 1% for operation at 0 to 15°C and 35 to 50°C.*

SC 504

- **80-MHz Bandwidth**
- **5-mV/div Maximum Sensitivity**
- **5-ns/Div Maximum Calibrated Sweep Rate**
- **Enhanced Automatic Triggering**
- **True X-Y Capability**
- **Switchable Rear-Interface Capability**

The SC 504 is a general-purpose, dual-trace, nondelayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH1 plus CH2), differential (CH1 minus CH2), and "true" X-Y modes, and also includes rear-interfacing capability (switchable CH1, CH2, and ext trig inputs). Enhanced autotriggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use.

SC 503

- **10-MHz Bandwidth, Dual Trace**
- **50-ns/Div Maximum Calibrated Sweep Rate**
- **1-mV/Div Maximum Sensitivity**
- **Bistable Storage Autoerase**
- **Trigger View, Variable Trigger Holdoff**
- **Switchable Front/Rear X and Y Inputs**
- **Rear Z-Axis Input**
- **True X-Y Capability**

The SC 503 is a nondelayed-sweep, general-purpose storage oscilloscope that can be used to store and display waveforms after the input signal is removed.

Important storage applications of the SC 503 include measurement of signals in computer peripherals, communication terminals, and industrial control systems.

The SC 503 also features an autoerase mode that erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause-and-effect testing relationships including: acoustic-speech testing, nerve-potential testing, and optical-stimulus-response testing.

STORAGE SYSTEM

Stored Writing Speed (Center 6 × 8 Divisions)—At least 80 div/ms (50 cm/ms).
Erase Time—400 to 600 ms.
Autoerase Viewing Time—Continuously variable from ≤0.5 to ≥5s.
Maximum Recommended Storage Time—≈4 hrs.

SC 502

- **15-MHz Bandwidth, Dual Trace**
- **20-ns/Div Maximum Calibrated Sweep Rate**
- **1-mV/Div Maximum Sensitivity**
- **Delay Line**
- **Trigger View, Variable Trigger Holdoff**
- **Enhanced Automatic Triggering**

The SC 502 is a compact general-purpose, 15-MHz dual-trace oscilloscope with high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering. It is designed to operate in any two adjacent compartments of a TM 500/TM 5000 mainframe.

The SC 502 is intended to be a powerful tool in the field servicing of digital equipment. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well-proven circuits. Thus, the SC 502 offers a unique combination of performance, compactness, and systems capability.

The rear-interfacing capability of the SC 502 and all TM 500/TM 5000 instrumentation suggests exceptional applicability to systems of built-in test equipment or rackmounted installations. The TM 515 Traveler mainframe with the SC 502, forms a nucleus for sophisticated, compact field-service "packages."

SC 501

- **5-MHz Bandwidth**
- **Single Compartment Size**
- **6.4-cm (2.5 in.) CRT**
- **Versatile Operating Features**

The SC 501 is a single-channel, 5-MHz plug-in-unit oscilloscope with a 2.5-inch CRT display that occupies a single TM 500/TM 5000 series plug-in compartment.

Since the SC 501 fits any TM 500 or TM 5000 mainframe, it can be used on the bench, in a rack, or on the road.

Calibrated sweep rates are selected by pushbutton logic in decade steps from 1 μs/div to 100 ms/div. A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0- to 10-V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear-interface connector.

The triggering circuits allow stable triggering from either internal or external sources. Autotriggering and manual Level/Slope selection are combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

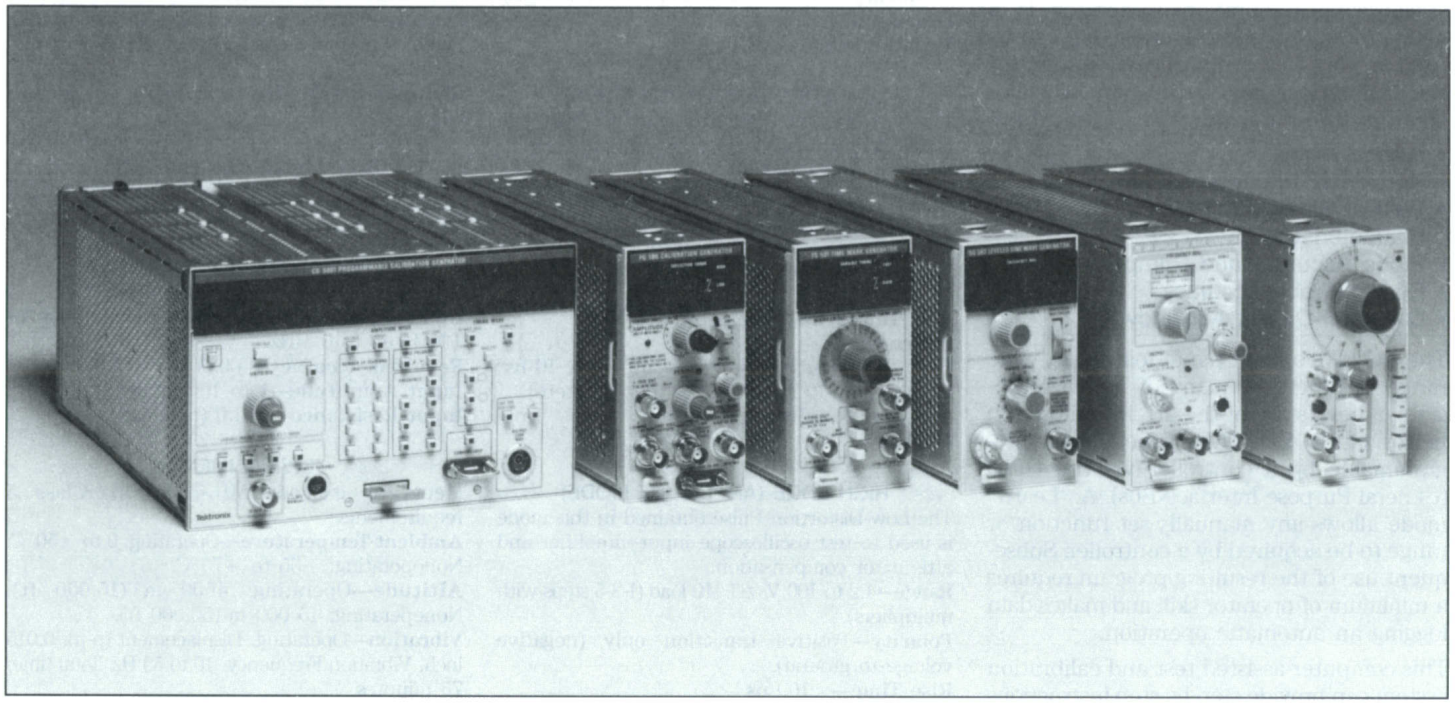
For X-Y operation, an internal switch converts the horizontal-deflection system of the SC 501 to an external horizontal amplifier that is internally calibrated for 100-mV/div deflection factor with a bandwidth of 100 kHz.

ORDERING INFORMATION

SC 504 80-MHz Oscilloscope **$3,960**
Includes: Instruction manual (070-2296-00). For Floating Measurements, order A6902A Isolator. See Accessories section for complete description.
SC 503—10-MHz Storage Oscilloscope **$4,160**
Includes: Instruction manual (070-3438-00).
SC 502 15-MHz Oscilloscope **$2,840**
Includes: Instruction manual (070-1878-01).
SC 501 5-MHz Oscilloscope **$1,820**
Includes: Instruction manual (070-1700-01).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

OSCILLOSCOPE CALIBRATION INSTRUMENTS



PRODUCT SUMMARY

The CG 5001 is the computerized solution to large-scale scope-calibration needs. The CG 5001 can be used as part of a computer-based system to calibrate and verify all major oscilloscope parameters and is specifically designed for use where many oscilloscopes are maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

In addition to the CG 5001, Tektronix offers a complete set of modular calibration instruments that can be configured into a portable test set for in-field oscilloscope service and calibration. These oscilloscope calibration instruments offer the widest range of standard amplitude square waves, fastest rise times, lowest aberrations, fastest time marks, and widest frequency range of leveled sine waves available today.

The TG 501 Time-Mark Generator provides crystal-controlled time marks from 5 s to 1 ns, plus a variable mode of operation that allows you to read the oscilloscope's timing error directly in percent from the digital display.

The PG 506 Calibration Generator provides clean, fast-rise square waves for checking oscilloscope transient response and calibrated-amplitude square waves for checking and setting the vertical-amplifier gain of the oscilloscope. Like the TG 501, the PG 506 has a variable mode of operation that allows you to read the oscilloscope's calibration error directly in percent from its digital display.

The SG 503 and SG 504 generators provide leveled sine waves for bandwidth checks (−3 dB points) and triggering performance checks. The SG 503 is a general-purpose leveled sine-wave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled sine-wave output that is variable from 245 to 1050 MHz in two bands. The SG 502 Oscillator benefits calibration applications where verification of low-frequency rolloff in ac modes and performance measurement of low-frequency-reject triggering modes is required.

Many of the calibration and test steps previously performed by the operator can now be transferred to a computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program can send control-setting information to the CG 5001, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions can be placed on a terminal to automatically coordinate the operator with the calibration signals being sent from the CG 5001. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 5001 returns error or deviation information to the controller, where it can be compared with preprogrammed reference values for the oscilloscope. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as a hard-copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front-panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

CG 5001

GPIB IEEE-488 — The CG 5001 is designed to support other products which comply with IEEE Standard 488-1978.

The Tektronix CG 5001 Programmable Oscilloscope Calibration Generator is a microprocessor-based generator that can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

- **Vertical Gain**
- **Horizontal Timing and Gain**
- **Vertical Bandwidth/Pulse Characteristics**
- **Probe Accuracy and Compensation**
- **Current-Probe Accuracy**
- **Calibrator-Output Accuracy**

The CG 5001's front panel features a wide range of functions, many of which represent a new state-of-the-art in calibration performance. All of these functions are programmable by a controller via the GPIB (General Purpose Interface Bus). A "Learn" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system can provide step-by step instructions to the operator, thus significantly reducing the skill level required.

The CG 5001 is designed to greatly reduce your maintenance costs. Built in self-test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature-analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

CHARACTERISTICS

VOLTAGE (AMPLITUDE MODE)

The standard voltage is used to calibrate vertical display accuracy.
Range—40 μV to 200 V (1-2-5 steps with multiplier).
Multipliers—1, 2, 3, 4, 5, 6, 8, 10 divisions.
Polarity—Positive from ground.
Accuracy—±0.25% ±1 μV.
Frequency—40 to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: dc or 10 Hz to 100 kHz. 12 to 200 V: dc or 10 Hz to 10 kHz.
Variable Range—±9.9%.

CURRENT (AMPLITUDE MODE)

The standard current is used to calibrate current probes.
Range—1 to 100 mA (1-2-5 sequence).
Multipliers—1, 2, 3, 4, 5, 6, 8, 10.
Accuracy—±0.25% ±2 μA.
Frequency—DC or 10 Hz to 1 MHz (decade steps).
Droop—≤1%.
Variable Range—±9.9%.

LOW EDGE (AMPLITUDE MODE)

The Low-Distortion Pulse obtained in this mode is used to test oscilloscope input-amplifier and attenuator compensation.
Range—20 mV to 1 V p-p (50-Ω load only) (1-2-5 steps with multipliers).
Multipliers—1, 2, 3, 4, 5, 6, 8, 10.
Polarity—Positive or negative transitions to ground.
Rise Time (Fall Time)—≤1.3 ns.
Aberrations—±2%.
Long-Term Flatness—±0.5% after first 10 ns.
Frequency—10 Hz to 1 MHz (decade steps).
Variable Amplitude Range—>±9.9% from nominal.

HIGH EDGE (AMPLITUDE MODE)

The Low-Distortion Pulse obtained in this mode is used to test oscilloscope input- amplifier and attenuator compensation.
Range—1.2 to 100 V, ≥1 MΩ load (1-2-5 steps with multipliers).
Polarity—Positive transition only (negative voltage to ground).
Rise Time—<100 ns.
Aberrations—±2% of square-wave amplitude.
Long-Term Flatness—±0.5% after first 500 ns.
Frequency—10 Hz to 100 kHz (decade steps).
Variable Amplitude Range—>±9.9% from nominal.

MARKERS (TIMING MODE)

The markers obtained in this mode are used to calibrate oscilloscope time bases.
Range—10 ns to 5 s (1-2-5 steps).
X10 Magnifier—Increase marker rate by a factor of ten (0.1 μs to 5 s range).
Accuracy—±0.01% (optional TCXO ±0.0003%).
Amplitude—1 V minimum into 50 Ω.
Variable Range—±9.9%.

SLEWED EDGE (TIMING MODE)

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.
Range—0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).
X10 Magnifier—Increases Slewed-Edge rate by a factor of ten (5 ns to 100 ns range).
Accuracy—±0.01% (Optional TCXO ±0.0003%).
Edge Position Uncertainty—±40 ps.
Amplitude—>1 V into 50 Ω.
Variable Range—±9.9%.

TRIGGER OUTPUT

The oscilloscope under test is normally triggered externally from this source.
Output Amplitude—1-V minimum into 50 Ω.
Trigger Rate (Marker Mode)—Normal: Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers. Divided by 10: Reduces normal trigger rate by a factor of ten. Divided by 100: Reduces normal trigger rate by a factor of one hundred.
Slewed-Edge Mode—One trigger per slewed edge.
All Other Modes—Normal: Slaved to output frequency. Divided by 10: One-tenth output frequency. Divided by 100: One-hundredth output frequency.

TIMING REFERENCE OUTPUT
EXTERNAL TIMING REFERENCE

Input Frequency—Any integral multiple of 1 MHz up to 5 MHz.
Required Accuracy—±0.001%.
Input Amplitude—1 to 10 V RMS.
Input Resistance—10 kΩ (nominal).

ENVIRONMENTAL

Meets or exceeds MIL-T-28800B, Class 5 requirements.
Ambient Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.
Altitude—Operating: 4500 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).
Vibration—Operating: Displacement (p-p), 0.015 inch. Vibration Frequency: 10 to 55 Hz. Total time: 75 minutes.
Relative Humidity—90% to 95% at +50°C for 5 days.
Shock—Nonoperating: 30 g's, ½ sine, 11-ms duration, three shocks in each direction along three major axes; total shocks, 18.
Bench Handling—Operating: 45° 4 inches or point of balance, whichever occurs first.

PHYSICAL CHARACTERISTICS*1

Dimensions	mm	in.
Width	203	8.0
Height	124	4.9
Depth	305	12.0
Weight ≈	**kg**	**lb**
Standard	3.9	8.5
Option 01	4.0	8.7

*1 *Maximum Overall Dimensions (triple compartment plug-in).*

PULSE HEAD (STANDARD ACCESSORY)
FAST EDGE (AMPLITUDE MODE)

The Pulse Head is used to generate fast-rise, low-distortion pulses for testing higher-bandwidth vertical amplifiers.
Polarity—Positive or negative transitions from ground.
Rise Time—≤200 ps.
Aberrations—±3% of pulse amplitude; not to exceed 4% p-p for adjacent peaks.
Frequency—100 Hz to 100 kHz (decade steps).
Amplitude—1.1 V peak ±5% into 50 Ω.
Variable Range—±10%.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

PG 506 Calibration Generator

- **Three Square-Wave Output Modes**
- **10 Hz to 1 MHz**
- **Direct Readout of Oscilloscope Deflection Error**

The PG 506 Calibration Generator provides three modes of square-wave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. Simultaneous plus and minus low-level, fast-rise (1.0 ns) square waves or high-amplitude (60 V), extremely clean square waves are available at frequencies from 10 Hz through 1 MHz for checking oscilloscope transient response. A 5-mA calibration current loop is useful for current-probe calibration. A 1-kHz square wave can be generated in the amplitude-calibration mode. Its amplitude can be varied around the calibrated level until the square wave aligns with the oscilloscope graticule divisions. Scope deflection error can then be read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

CHARACTERISTICS

AMPLITUDE-CALIBRATOR MODE

Period—Fixed at ≈1 ms or dc.
Amplitude—From 200 μV p-p to 100 V p-p in 1-2-5 sequence, accurate within 0.25% into 1 MΩ. 100 μV p-p to 5 V p-p into 50 Ω.
Error Readout—Range: ±7.5%. Resolution: 0.1%.

PULSE MODES

Period—1 μs to 10 ms (within 5%) in decade steps with the variable control in Cal position. Variable extends period to at least 100 ms.
Symmetry—≈50% duty cycle.

HIGH-AMPLITUDE OUTPUT

Rise Time—Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.
Amplitude Range—Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.
Leading-Edge Aberrations—Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.
Polarity—Positive going from a negative potential to ground.
Output Source Resistance—600 Ω within 5%.

FAST-RISE OUTPUTS

Rise Time (Terminated Into 50 Ω)—<1.0 ns.
Amplitude Range (Terminated Into 50 Ω)—100 mV or less to at least 1.0 V.
Leading-Edge Aberrations—Within 2% or 10 mV p-p, whichever is greater, during first 10 ns.
Flatness—Within 0.5% after first 10 ns.
Polarity—Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.
Output Source Resistance—50 Ω within 3% at + and − output connectors.
Trigger Output (Terminated into 50 Ω)—Positive-going signal of at least 1 V.

TG 501 Time-Mark Generator

- **Marker Outputs, 1 ns to 5 s**
- **Direct Readout of Oscilloscope Timing Error**
- **External Trigger Output**

The TG 501 Time-Mark Generator provides marker outputs from one nanosecond to five seconds. A unique feature of the TG 501 is a variable timing output with a front-panel two-digit LED display. The display indicates percentage of timing error between the normal time interval and a variable interval that lines up the marker pulse with graticule or division marks on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

CHARACTERISTICS

Markers—1 ns through 5 s in a 1-2-5 sequence.
Marker Amplitude—≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.
Trigger-Output Signal—Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base

Crystal Frequency	5 MHz
Stability (0 to 50°C) after ½ hour	within 5 parts in 10^7
Long-Term Drift	1 part or less in 10^7 per month
Setability	adjustable to within 5 parts in 10^9

External Reference Input—Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL-compatible.
Timing-Error Readout Range—To 7.5%.
Timing-Error Measurement Accuracy—Device under test error is indicated to within one least significant digit (to within one displayed count).

SG 503 Signal Generator

- **250 kHz to 250 MHz**
- **Leveled, Variable Output**
- **Digital Readout of Frequency**

The SG 503 Signal Generator provides a leveled output that is variable in frequency from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED readout on the front panel. Accurately calibrated output voltage is variable from 5 mV to 5.5 V peak-to-peak into 50 Ω.

CHARACTERISTICS

Frequency Range—250 kHz to 250 MHz, plus 50-kHz reference frequency.
Frequency Accuracy—Within ±0.7 of one count of the least significant digit of indicated frequency.
Amplitude Range—5 mV to 5.5 V p-p into 50-Ω termination in three decade ranges.
Amplitude Accuracy (50-kHz Reference)—Within 3% of indicated amplitude on (X1) range, 4% on (X.1) range, and 5% on (X.01) range.
Flatness (P-P)—From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 and 100 MHz on amplitude multiplier X.1 and X.01 ranges only. From 100 to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.
Harmonic Content—Second Harmonic: At least 35-dB down. Third Harmonic and All Higher Harmonics: At least 40-dB down.
Rear-Card-Edge Connection—Addresses the leveling circuit.

SG 504 Signal Generator

- **245 to 1050 MHz**
- **Leveled, Variable Output**
- **Frequency-Modulation Capability**

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V p-p into 50 Ω.

CHARACTERISTICS

Frequency Range—Low Band: 245 to 550 MHz. High Band: 495 to 1050 MHz, plus 50-kHz or 6-MHz reference frequency (internally selected).
Frequency Accuracy—±2% of dial indication.
Amplitude Range—0.5 V to at least 4.0 V p-p.
Amplitude Accuracy (At Reference)—Within 3% of indicated amplitude.
Flatness—±4% of amplitude at reference frequency.
Harmonic Content—Second Harmonic: At least 25-dB down. Third Harmonic and All Higher Harmonics: At least 40-dB down.
FM Input—Frequency Range: DC to 100 kHz. Deviation Sensitivity: ±9 V produces from 0.05% to 0.5% deviation of carrier, depending on output frequency.
Frequency Monitor Output—≥0.3 V p-p into a 50-Ω load from 245 to 1050 MHz.
Rear-Card-Edge Connections—Address FM input, frequency-monitor output, and amplitude control.

SG 502 Oscillator

- **5-Hz to 500-kHz Sine Waves and Square Waves**
- **Low-Distortion Sine Wave**
- **5-V RMS Open Circuit—600-Ω Source**
- **0- to 40-dB Output Variable Plus 0 to 70 dB in 10-dB Steps**

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes. Other SG 502 features include 70-dB amplitude control plus a simultaneous fixed-amplitude square wave.

CHARACTERISTICS

SINE WAVE

Frequency Range—5 Hz to 500 kHz in 5-decade steps. Accurate within 5% of dial setting from 5 Hz to 50 kHz; within 10% of dial setting from 50 to 500 kHz.
Amplitude Response (1-kHz Reference)—Flatness is 0.3 dB over entire range.
Attenuation—Selectable from 0 to 70 dB in 10-dB steps with pushbuttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 to −40 dB.
Harmonic Distortion—<0.035% (−70 dB) from 20 Hz to 50 kHz. <0.15% from 50 to 500 kHz ($R_L \geq 600\ \Omega$).
Maximum Output Voltage—5 V RMS open circuit; 2.5 V RMS into 600 Ω.
Output Impedance—600 Ω, grounded.

SQUARE WAVE

Frequency Range and Accuracy—Same as sine wave. The square wave switches on the 0° phase of sine out.
Rise Time and Fall Time—50 ns or less.
Amplitude—+5 V, fixed, open circuit.
Output Impedance—600 Ω, grounded.

SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.
Input Impedance—10 kΩ.

Tunnel-Diode Pulser

The Tunnel-Diode Pulser provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. It can be driven by the PG 506 at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 Ω, while rise time is ≤125 ps; aberrations are <1% in a 1-GHz system.

Precision Voltage Divider

Designed for use with the PG 506 in the Standard-Amplitude mode, this 0.4 divider allows your oscilloscope to display a constant four divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display five divisions of amplitude.

CHARACTERISTICS

Input Z—50 Ω with output load ≥100 kΩ.
Maximum Input—≤5 V RMS.
Output—0.4 x PG 506 amplitude.
Voltage Accuracy—0.4%.

MAINFRAMES

CG 5001 requires either a TM 5003 or TM 5006. The CG 551AP is a TM 500 version of the CG 5001 and requires a TM 506 Mod JB, TM 515 Mod UB or RTM 506 Mod JB. The CG 5001 is not compatible with TM 500 power-module mainframes.

ORDERING INFORMATION

CG 5001 Programmable Calibration Generator — **$14,995**
Includes: Output cable assembly (012-0884-00); pulse head (015-0311 01); instrument interface guide (070-4616-00); program CAL GEN (070-4768-00); instruction manual (070 4767-00).
CG 551AP Programmable Calibration Generator — **$14,995**
PG 506 Calibration Generator — **$3,050**
Includes: Instruction manual (070-3383-00).
TG 501 Time-Mark Generator — **$2,670**
Includes: Instruction manual (070-1576-02).
SG 503 Signal Generator — **$2,450**
Includes: Three-foot precision 50-Ω cable (012-0482-00); instruction manual (070-1622-01).
SG 504 Signal Generator — **$4,060**
Includes: Leveling Head, instruction manual (070-1632-01).
Replacement Leveling Head Order 015-0282-00 — **$525**
SG 502 Oscillator — **$1,150**
Includes: Instruction manual (070-1430-01).
Precision Voltage Divider Order 015-0265-00 — **$180**
Tunnel-Diode Pulser Order 067-0681-01 — **$210**

OPTIONS
(CG 5001/CG 551AP only)

Option 01—Adds High-Accuracy Time Base (TCXO) CG 5001/CG 551AP. — **+$650**
Option 02—Deletes Pulse Head CG 5001/CG 551AP. — **−$,100**

(TG 501 only)

Option 01—Precision Time Base — **+$325**

UTILITY SOFTWARE

See System Support section for description for TM 5000/4041. Order 062-6958-01 — **$150**

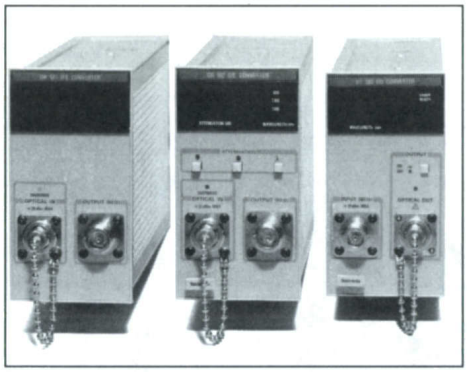
CONVERSION KIT

CG 551AP—Field Modification Kit to convert to CG 5001. Order 040-1041-02 — **$180**

OPTIONAL ACCESSORIES

Comparator Head—Used to calibrate built-in oscilloscope calibrators against the signals available from the CG 5001. Both the oscilloscope calibrator and CG 5001 standard-amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 5001 signals are then varied to obtain congruent displays. Errors are then displayed on the CG 5001 readout. Order 015-0310-01 — **$670**
Remote Variable—Permits remote operation of the following front-panel controls: Units/Div, Variable-Fixed Button, Continue Pushbutton, and the VAR. Order 015-0309-01 — **$465**
Pulse Head—(When purchased separately.) Order 015-0311-01 — **$1,485**
Circuit Board Extenders—(Rigid) Order 067-0975-00 — **$125**
(Flexible) Order 067-0974-00 — **$235**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.



Electrical/Optical Optical/Electrical Converters

The OT501/502/503 Transmitters and OR501/502 Receivers are designed to transmit and receive signals across fiber. The receivers can be used to convert most instruments to optical instruments (e.g., the optical scope).

Designed as a TM 500 plug-in, they can be used in any TM 500/TM 5000 mainframe.

ORDERING INFORMATION

OT501 825 nm E/O Converter	**$5,900**
OT502 850 nm E/O Converter	**$5,900**
OT503 1300 nm E/O Converter	**$9,500**
OR501 O/E Converter	**$4,300**
OR502 O/E Converter	**$6,500**
OPTIONS	
Option 20—AT&T Biconic Connector	**NC**
Option 21—Diamond 3.5 Connector	**NC**
Option 22—FC Connector	**NC**

OT501/502/503 TRANSMITTERS

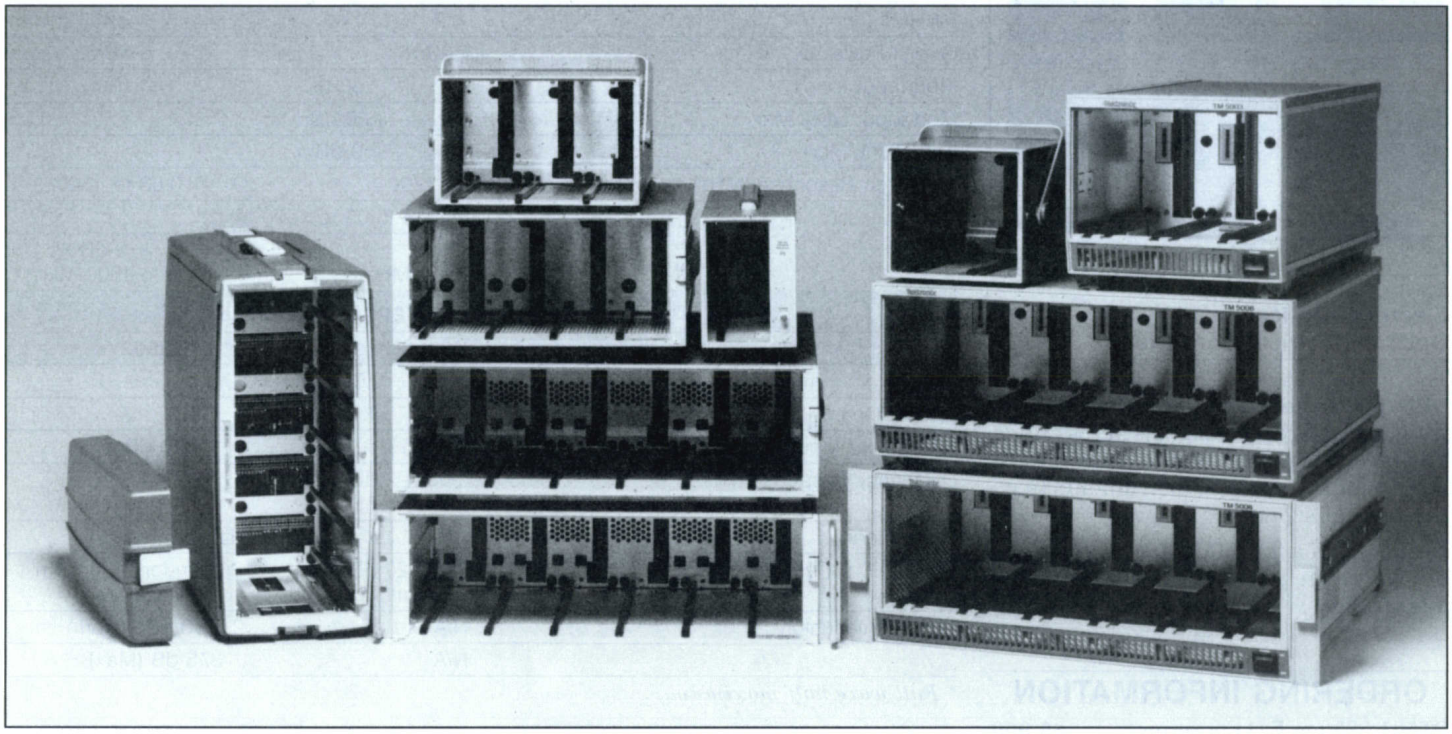
	OT501	OT502	OT503
Wavelength (nm)	825 ±15	850 ±10	1300 ±25
FWHM* (nm)	<2		<4
Output Power, DC	+3 dBm		0 dBm
Mod Input	50 Ω		
Mod Input Level Max	+20 dBm		
with 100% Mod	<0 dBm		
Mod Freq Response (MHz)	0.03 to 1700		0.03 to 1500
Mod Flatness	± 1 dB (0.05 to 1000 MHz)		
	± 2 dB (0.03 to 1700 MHz)		± 5 dB (0.03 to 1500 MHz)

OR501/502 RECEIVERS

	OR501	OR502
Wavelength (nm)	700 to 1500	
Photo Element	Ge-APD	
Max Linear Input	−20 dBm	+10 dBm
Frequency Response (MHz)	0.03 to 1500 ±2 dB 0.05 to 1000 ±1 dB	
Noise Floor	≤ −110 dBm/Hz	
Output 50 Ω (Typical)	−15 dBm for −20 dBm optical input	−12 dBm for −20 dBm optical input
Optical Attenuator	N/A	2.5 dB/step (Nom)
	N/A	37.5 dB (Max)

* *Full wave half maximum.*

MAINFRAMES



TM 5003/TM 5006

Power Module Mainframes

GPIB IEEE-488 — The TM 5003 and TM 5006 comply with IEEE Standard 488-1978.

The TM 5000 mainframes extend the convenience of the TM 500 concept into the programmable instrument/IEEE Standard 488 area. The TM 5003 accepts up to three instruments at one time; the TM 5006 accepts up to six. These two TM 5000 mainframes were designed specifically for use with the Tektronix TM 5000 line of programmable, IEEE Standard 488 compatible test-and-measurement instruments. All of the TM 500 manual plug-in instruments will also operate in these same mainframes allowing manual and programmable instruments to be mounted together in adjacent slots. This capability permits unique compact combinations of test instruments to be assembled for specific test applications.

TM 5000 instruments cannot be operated in TM 500 mainframes.

Benchtop or Portability

The two benchtop mainframes are the TM 5003 and the TM 5006. The TM 5003 is the most compact, accommodating three single-wide plug-ins. The TM 5006 includes a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher-output levels. Both the TM 5003 and TM 5006 incorporate a quiet fan for optimum cooling; have feet, tilt-bails, handles, and front-panel power switches. Both operate from 110 or 220 V ac.

All benchtop models have carry handles for portable applications.

Rackmount

The TM 5006 Option 10 is electrically identical to the standard TM 5006 and features a slide assembly and handles, plus a higher-power fan than the bench version to accommodate the higher ambient temperatures often found in enclosed racks and consoles. Kits are available to rackmount a TM 5003 with a 4041 System Controller.

CHARACTERISTICS

POWER REQUIREMENTS

Both mainframes have manually selectable taps on the power transformer that permit operation on 100, 110, 120, 200, 220, or 240 V ±10%.

Power-Line Frequency Range—48 to 66 Hz.

Maximum Power Consumption—Shown in Mainframes Dimensions and Weights chart.

PHYSICAL CHARACTERISTICS MAINFRAMES (WITHOUT PLUG-INS)

	TM 5003		TM 5006	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	230	9.0	445	17.5
Height	194	7.6	194	7.6
Depth	488	19.2	488	19.2
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	8.6	19.0	14.5	32.0
Shipping	12.0	26.5	20.9	46.0
Maximum Power Consumption*1	300 V A		650 V A	

*1 *Actual power consumption depends on plug-in selection and operating modes.*

ENVIRONMENTAL

Temperature Range—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.

Altitude Range—Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea Level to 15,000 m (50,000 ft).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

TM 500 Power Module Mainframes

TM 500 POWER MODULE MAINFRAMES

TM 500 plug-ins can operate in several different mainframes, including benchtop, portable, and rackmount configurations in the TM 500 line and in the TM 5000-Series mainframes. This allows hundreds of different instrumentation packages to be configured for specific tasks.

Benchtop

Five benchtop mainframes are available in the TM 500 series. The TM 501 is the most compact, accommodating one single-width TM 500 module. Others in the series include the TM 502A, TM 503A, TM 504, and TM 506. The TM 504 and TM 506 both include a high-power compartment at the right side to supply higher current levels. The TM 506 incorporates a quiet fan for maximum cooling. All benchtop models have feet, tilt-bails, and handles, and operate from 110 to 220 V ac.

Portability

All benchtop models but the TM 501 and TM 502A have optional protective front covers to further enhance portable applications. The TM 515 Traveler Mainframe is designed for even greater multi-instrument portability. The TM 515 is moisture- and dust-resistant, and will withstand the rigors of transport.

Rackmount

The RTM 506 rackmount and TM 506 mainframes are electrically identical.The RTM 506 has a slide assembly and handles, plus a higher-power fan to accommodate higher ambient temperatures.

CHARACTERISTICS

ENVIRONMENTAL

Temperature Range—Operating: 0 to +50 °C. Nonoperating: −55 to +75 °C.

Altitude Range—Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15000 m (50,000 ft).

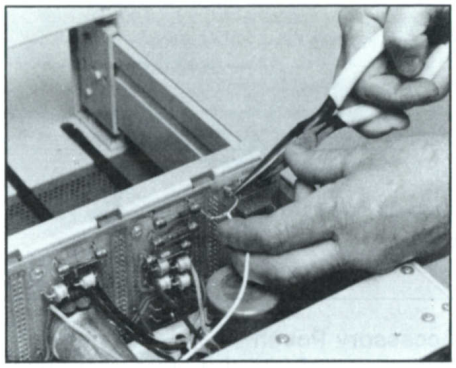
POWER REQUIREMENTS

The mainframes have selectable taps on the power transformer that permit operation on 100, 110, 120, 200, 220, or 240 V ±10%.

Power-Line Frequency Range—TM 501: 48 to 440 Hz. TM 502A/TM 503A: 48 to 400 Hz. TM504/ TM 506/RTM 506/ TM 515: 48 to 66 Hz. TM 515 (Purchased with Option 06): Extends upper power-line frequency range to 440 Hz.

Mainframe Rear Interface

TM 5000/TM 500 mainframes offer the unique ability to have separate modular instruments interconnected through the rear-interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks. Or, a digital multimeter and power supply can be interconnected



"Mainframe Rear Interface"

to speed precise voltage set-ups. Any module can be internally connected through the mainframe and externally interfaced out the back panel.

Some modules have additional signal or control lines at the back of the instrument. Different modules can be interconnected to reduce front-panel clutter or to perform functions not otherwise available.

The TM 515 mainframe is available with an Option 05 interface that includes everything in the Option 02 except for the rear-panel male connector, mating cable "D" connector, and BNC connectors.

A *Rear Interface Data Book* (Part 070-2088-04) contains information on the interfacing capability of each instrument "family."

Tektronix also makes a low-cost "do-it-yourself" Rear-Interface Modification Kit.

ORDERING INFORMATION

TM 5003 Power Module Mainframe **$850**
Includes: Instruction manual (070-2955-00).
TM 5006 Power Module Mainframe **$995**
Includes: Instruction manual (070-2950-00).
TM 501 Power Module Mainframe **$500**
Includes: Instruction manual (070-1304-01).
TM 502A **$235**
Includes: Instruction manual (070-6502-00)
TM 503A Power Module Mainframe*1
Includes: Instruction manual (070-6568-00).
TM 504 Power Module Mainframe **$590**
Includes: Instruction manual (070-1716-01).
TM 506 Power Module Mainframe **$690**
Includes: Instruction manual (070-1786-02).
RTM 506 Rackmount Power Module Mainframe **$750**
Includes: Instruction manual (070-1786-02).
TM 515 Power Module Mainframe **$760**
Includes: Instruction manual (070-2020-02).

OPTIONS

Option 02—Rear Interface
(TM 5003) **+$100**
(TM 5006) **+$190**
(TM 503A)*1
(TM 504) **+$590**
(TM 506) **+$690**

Option 05—(TM 515) Rear Interface **+$90**
Option 06—48 to 440 Hz Fan. **+$170**
Option 10—Rackmount (TM 5006 only) **+$100**
Option 11—(TM 502A/TM 503A) Deletes handle **−$10**
Option 13—(TM 502A/TM503A) Toolbox **+$75**
Option 12—Option 02 and 10 Combined (TM 5006 only) **+$290**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

*1 Contact your local Sales Office for information.

OPTIONAL ACCESSORIES

Rear Interface Data Book—
Order 070-2088-04 **$15**

CONVERSION KITS

Cabinet-to-Rackmount—
(TM 5006 only) Equipped with slide out assembly, to convert a TM 5006 to rackmount capability.
Order 040-0982-02 **$160**

Rackmount-to-Cabinet—
(TM 5006 only) Equipped to convert a TM 5006 with rackmount capability to cabinet style.
Order 040-0983-00 **$90**

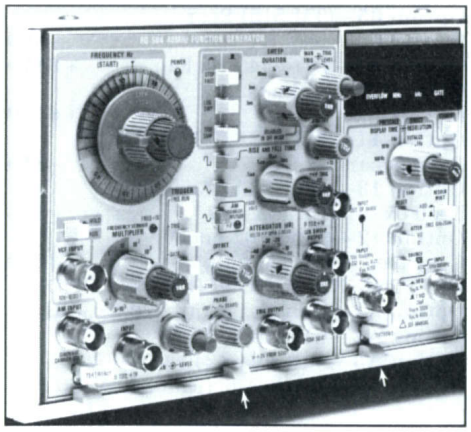
Cabinet-to-Rackmount—
(TM 5003 only) Equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003. Order 040-0984-01*1

FLEXIBLE PLUG-IN EXTENDER CABLE

Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear-interface board connection extender, cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out. See page 472.

RECOMMENDED CARTS

See Accessories section.
206—Utility Cart **$250**
K213—Lab Instrument Cart **$625**
K217—Rack Instrument Cart **$510**



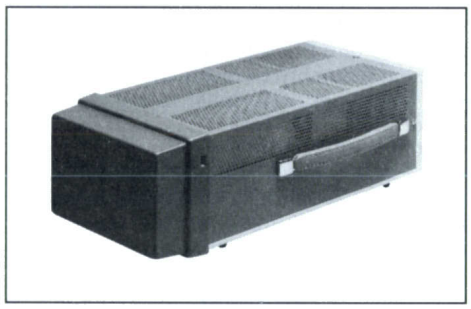
Mainframe Retainer Bar

You can modify the TM 504 or RTM 506/TM 506 mainframe; each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit.

ORDERING INFORMATION

Mainframe Retainer Bar Kit

(TM 504) Order 020-0548-00	$55
(TM 506/RTM) Order 020-0549-00	$60



Protective Front Cover

A snap-on front cover, molded of high-impact plastic, is available for the TM 503A (shown above), TM 504, and TM 506 mainframes. The cover adds 45 mm (1.75 in.) to the length of the TM 503A, TM 504, and TM 506 mainframes, and clears the longest knob projections on any of the instruments.

ORDERING INFORMATION

Front-Panel Cover.

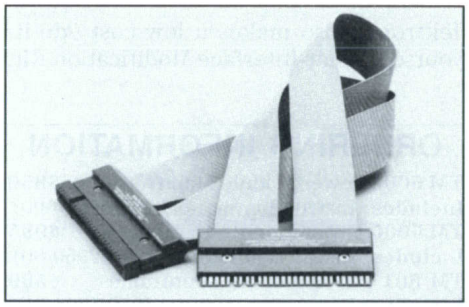
(TM 504) Order 200-1727-00	$20
(TM 506) Order 200-1728-00	$21

Accessory Pouch

While the TM 501, TM 502A, TM 503A, TM 504, TM 506, and TM 5003/TM 5006 mainframes were designed primarily for bench use, they are frequently carried for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem. Sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 5000/TM 500 mainframe or Tektronix oscilloscope, or the straps can be snapped together to form a carrying handle for the pouch to be used independently. Dimensions ≈ 9¼ in. long×5¾ in. wide×2 in. high.

ORDERING INFORMATION

Accessory Pouch. Order 016-0351-00 $32

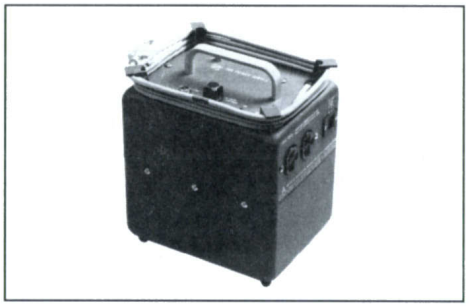


FLEXIBLE PLUG-IN EXTENDER CABLE

Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear-interface board connection extender, cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

ORDERING INFORMATION

GPIB Extender Cable for TM 5000 mainframes. Order 067-0996-00	$145
Extender Cable for TM 500/TM 5000 mainframes. Order 067-0645-02	$360
GPIB Interconnecting Cables—	
(0.5 m) Order 012-1015-00	$85
(2 m) Order 012-0630-01	$95
(2 m) Double Shielded. Order 012-0630-03	$110



1105 Battery Power Supply

TM 500 instruments in their mainframes can be operated with the 1105 Battery Power Supply when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered and their operating mode. The following table shows estimated operating time for a full mainframe in a typical situation.

TM 501	5.0 hours
TM 502A	2.5 hours
TM 503A	1.7 hours
TM 504	1.3 hours
TM 506	0.9 hours
TM 515	1 hour

ORDERING INFORMATION

1105 Battery Pack	$2,090
Option 01—230 V Operation	NC

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

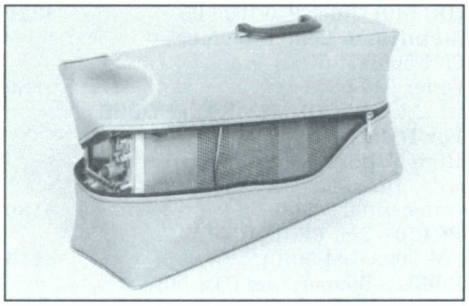
TM 500 Carrying Case

These luggage-type carrying cases for TM 500 equipment are molded of high-strength glass-epoxy. The TM 504 case has a molded foam insert that will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 610 mm long×216 mm thick×445 mm high, (24 in. long by 8.5 in. thick by 17.5 in. high) and weighs ≈14 pounds empty.

ORDERING INFORMATION

Carrying Cases

(TM 504) Order 016-0608-00	$520
(TM 515) Order 016-0643-00	$615



Rain Covers

These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503A and TM 504 instrumentation packages and include adequate space for protective front covers. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

ORDERING INFORMATION

Rain Covers

(TM 504) Order 016-0621-00	$45
(TM 503) Order 016-0620-00	$35

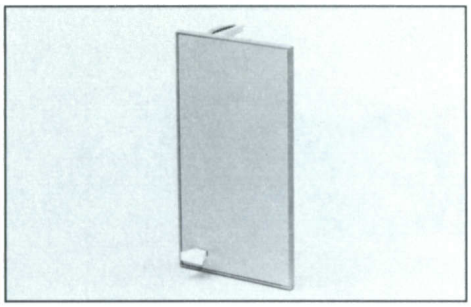
K213 shown with 436-0132-01 optional shelf.

The Lab Cart is especially designed for rollabout configuration combining TM 5000/TM 500 Instrumentation with the Tektronix oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray and shelves accept all TM 5000/TM 500 Series mainframes that are up to four plug-in modules wide, or an oscilloscope. Additional shelves are available as optional accessories. The power distribution module on the rear underside of the top tray provides four power outlets and a 15-foot line cord.

See Accessories section for additional information.

ORDERING INFORMATION

K213 Lab Instrument Cart	$625
OPTIONS	
Option 05—Delete Power Strip.	NC
Option 10—7854 keyboard drawer	+$195
Option 12—5000/7000 Series plug-in storage cabinet	+$140
Option 22—Combines Options 10 and 12.	+$295
Additional Lower Shelf—Order 436-0132-01	$65
Safety Belt to secure oscilloscopes or TM 5000/TM 500 to top tray or lower shelves (not needed for 5000 Series or 7000 Series on top tray). Order 346-0136-01	$32



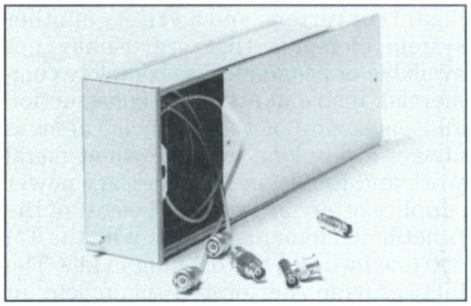
TM5000/TM500 Blank Plug-in Panel

When operating TM 5000/TM 500 instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

ORDERING INFORMATION

Blank Plug-in Panel

Order 016-0195-03	$33



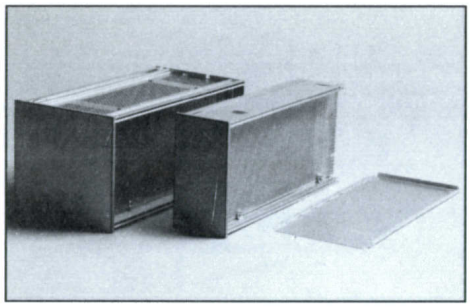
Plug-in Storage Compartment

Electronic engineers or technicians away from their bench seldom have enough storage space for probes, cables, "tees," accessories, and small tools. The plug-in storage compartment is a useful adjunct to many roll-about and Travel Lab configurations. If all five compartments in your TM 515 Traveler mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount installation might profit by readily available terminators or attenuators in an unused compartment. Compatible with all main frames; inside dimensions 250 mm L×51 mm W×106 mm H (9⅞ in. L×2 in. W×4¼ in. H).

ORDERING INFORMATION

Plug-In Tool Box

Order 016-0362-02	$75



TM 500 Custom Plug-In Kits

Single and Double Compartment Sizes

A complete test-and-measurement set-up for many typical jobs requires at least one nonstandard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements that are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceeds the cost of the functional elements. This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards that allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails , side cover, front sub-panel, blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage-regulator ICs can be used to provide exact voltages for most individual power-supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 instrumentation.

Single Compartment With Power Supply

A blank plug-in kit complete with power supply parts and circuit board layout is now available. A single-wide compartment, this plug-in kit saves set up and build time as the power-supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

(1) A ground-referenced positive supply, capable of +7 to +20 V at up to 400 mA. (Adjustment is centered at 15 V; change of resistor values required for total 7 to 20-V range).

(2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.

(3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 construction notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits and Thermal True RMS Converter.

ORDERING INFORMATION

Custom Plug-in Kits—
(Single Compartment with Power Supply) Order 040-0803-02 — **$135**
(Single Compartment) Order 040-0652-05 — **$115**
(Double Compartment) Order 040-0754-07 — **$170**
(Single Compartment Without ECB) Order 040-0821-03 — **$70**

Coaxial Cables, BNC F-F—
(all PGs) 10-inch, 50-Ω. Order 012-0208-00 — **$28**
(PG 502/PG 506/SG 503) 3-ft, 50-Ω Order 012-0482-00 — **$28**

Test Leads—
(all DMMs) Black, 4-ft. Order 012-0425-00 — **$12.75**
(all DMMs) Red, 4-ft. Order 012-0426-00 — **$23**
(all DMMs) Black, 4 ft. Order 012-0426-01 — **$23**

Test-Lead Set—(all DMMs) Order 012-0427-00 — **$29**

BNC-to-RF Cable Adapter—
DC 510/DC 5010) Order 012-0532-00 — **$37**

GPIB Interconnect Cables—
(0.5 m) Order 012-1015-00 — **$85**
(2.0 m) Order 012-0630-01 — **$95**
(2.0 m, double shielded) Order 012-0630-03 — **$110**

Precision Voltage Divider—
(PG 506) Order 015-0265-00 — **$180**

Remote Variable—(CG 5001) Order 015-0309-01 — **$465**

Comparator Head—(CG 5001) Order 015-0310-01 — **$670**

Pulse Head—(CG 5001) Order 015-0311-01 — **$1,485**

Manual Trigger Generator—
(PG 501/all SCs) Order 016-0597-00 — **$210**

Adapters—
(GR-to-BNC) Order 017-0064-00 — **$100**
(GR-to-BNC Female) Order 017-0067-00 — **$55**
(Female BNC-to-Dual Banana) For all DMMs. Order 103-0090-00 — **$9.50**
(BNC-to-Tip Jack) For DC 503A/DC 5010/DC 5009. Order 175-3765-01 — **$32**

Power Divider—50-Ω. Order 017-0082-00 — **$800**

Rear-Interface Signal Cable Kit—(FG 5010) Order 020-0701-00 — **$40**

Extender Cable—(TM 500/TM 5000) Order 067-0645-02 — **$360**

Tunnel Diode Pulser—(PG 506) Order 067-0681-01 — **$210**

Circuit Board Extenders—
(Flexible) Order 067-0974-00 — **$235**
(Rigid) Order 067-0975-00 — **$110**

GPIB Extender Cable—(TM 5000 only) Order 067-0996-00 — **$145**

Service Kit—(FG 5010) Order 067-1041-00 — **$410**

Rear-Interface Data Book—
Order 070-2088-04 — **$15**

CONVERSION KITS

Cabinet-to Rack Mount—
(Two TM 503s) Order 040-0616-02 — **$215**
(One TM 503) Order 040-0617-02 — **$395**
(TM 506) Order 040-0761-04 — **$325**
(TM 5006 only) Order 040-0982-02 — **$160**
(TM 5003 only) Order 040-0984-01*1

Rack Mount-to-Cabinet—
(One TM 503) Order 040-0618-01 — **$100**
(RTM 506) Order 040-0762-01*1
(TM 5006 only) Order 040-0983-00 — **$90**

GPIB Capability—
(DC 509) Order 040-0957-04 — **$325**
(DC 510) Order 040-1023-05 — **$320**

Mainframe Rear Interface—
(TM 500/TM 5000) Order 040-0846-01 — **$80**

RECOMMENDED PROBES

For DMMs

High Voltage—
(DM 501A/DM502A/DM5010) Order 010-0277-00 — **$180**

P6420—2-m RF (DM 501A/DM 502A/DM 5010) — **$155**

P6601—Temperature (DM 501A/DM 502A)*1

For DCs

P6056—10X, 50-Ω, 3.5 GHz (DC 503A/DC 509/DC 510/DC 5009/DC 5010/DP 501) — **$200**

P6101A—1X, 34 MHz (DC 504A) — **$53**

P6106A—10X, 300 MHz (DC 510/DC 5010) — **$140**

P6125—5X Passive (DC 503A/DC 509/DC 510/DC 5009/DC 5010 — **$75**

P6201—FET, 900 MHz (DC 510/DC 5101/DP 501) — **$1,280**

P6230—Bias/Offset, 1.5 GHz (DC 503A/DC 509/DC 510/DC 5009/DC 5010/DP 501) — **$420**

SOFTWARE
(See System Support section)

Utility Software—For all TM 5000 instruments and 4041. Order 062-6958-01 — **$150**

S45F010—TEK EZ-TEST for 4041 with 410x/420X — **$500**

S45F020—TEK EZ-TEST for 4041 with ANSI 3.64-Term — **$500**

S45F902—Audio TPG for AA 5001/SG 5001 with 4041 — **$300**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

ACCESSORIES

CONTENTS

Digitizing Camera System 476
Video Copiers 478
Color Plotter 479
Cameras and Adapters 480
Opto-Electrical Converters 496
Digital Photometer/Radiometer .. 497
Instrument Carts 502
Fixtured Microprobes 506
Passive Voltage Probes 511
High Voltage Probes 515
Active Voltage Probes 519
Differential Probes 521
Specialty Probes 522
Current Probes 523
Instrument Isolators 527
Probe Accessories 529
Adapters and Connectors 532
Mounting Accessories 534
Viewing Accessories 535

THE STRONGEST LINK BETWEEN YOUR INSTRUMENT SYSTEM AND RESULTS

Tek offers the industry's widest selection of instrument accessories, optimized to enhance and augment your total measurement system. Whether your needs involve signal acquisition, measurement documentation, or simply physical convenience, Tek accessory products will complete your measurement system and add new dimensions to it's usability and performance.

CAMERAS/DOCUMENTATION/ IMAGING PRODUCTS

The Tek Digitizing Camera System, along with an IBM or compatible PC and companion video copiers, turn any analog oscilloscope into a digitizer scope, allowing complex waveform analysis and documentation.

Film-based cameras permit inexpensive, flexible solutions to measurement documentation, allowing you to communicate your measurement results with convenience and clarity.

The HC100 Color Plotter allows you to produce high-quality color plots from a number of Tek digital-based instruments.

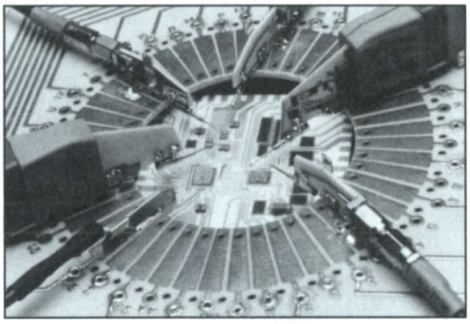
OPTO-ELECTRICAL CONVERTERS AND DIGITAL PHOTOMETER/RADIOMETER

Tek opto-electrical converters and digital photometer/radiometer offer solutions in applications involving the measurement of light. High-speed analog optical waveform measurements (e.g., development of fiber-optic communications systems) can be accomodated with Tek's new family of opto-eletrical converters, while those involving luminance, illuminance, and irradiance can be made quickly and easily with Tek's photometer/radiometers.

SIGNAL ACQUISITION PRODUCTS

Tek signal-acquisition products are engineered to couple signal intelligence from its source to the measurement system with minimum effect on the signal source (loading) and on the signal itself (distortion). Whether your application involves high-voltage, low-voltage, differential, or current measurements, Tek signal-acquisition products will make the critical difference.

A comprehensive booklet on signal-acquisition techniques and considerations



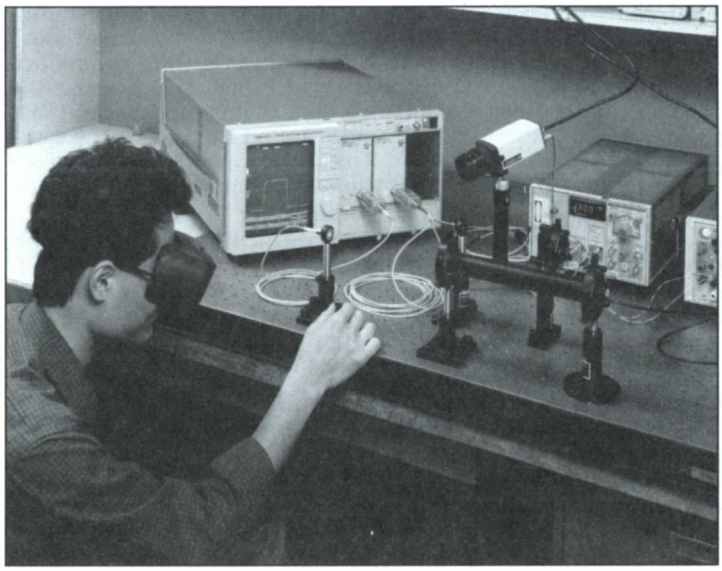
(THE ABC's OF PROBES) contains easy-to-understand information on probe specifications, applications, and selection criteria. For your free copy, ask your Tektronix Sales Engineer for Literature No. 60-W-6053, or call toll free in the USA 1-800-426-2200. In Oregon, call collect 503-627-9000.

INSTRUMENT ISOLATORS

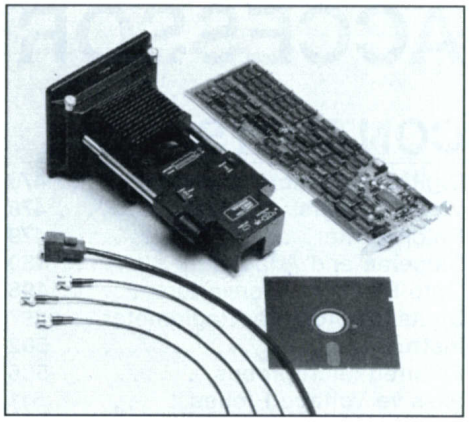
If your application involves elevated (i.e., "floating") measurements, Tek instrument isolators offer solutions which combine high-quality measurement performance and operator safety.

INSTRUMENT CARTS

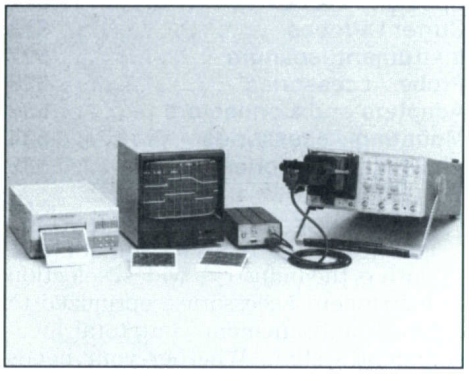
Tek instrument carts allow you to add mobility, security, and convenience to your measurement system. They easily integrate into your system and provide a convenient means of keeping your system elements accessible and together. They also remove clutter and confusion from valuable engineering bench space, while allowing your measurement system to be moved from site to site and to be shared by multiple users.



DSC01 System: DCS, PEP 301 controller, 2467 scope, HC01 copier, and SPD.



DCS01—The Digital Camera System includes a C1001 Video Camera (shown with Option 1A), frame store board, software, and cables.



C1001, DX02, and HC01 in a documentation application.

DCS01 Digitizing Camera System

The DCS is an imaging system that can be used to capture and digitize waveforms from a scope's CRT. The DSC uses the processing power of the PC to analyze the waveforms. See pages 390–391 for additional information.

SOFTWARE

By using optional software packages, the capabilities of the DCS are enhanced:

S58DC01 DCS Functional Library/ Source Code.

- Multiple cards in one PC.
- Define the delta mask.
- Sum Incoming Videor with the Video Memory

This package allows the user to program the operation of the DCS frame store card. It does not access the data manipulation capabilities of the DCS. A knowledge of the "C" language and the Microsoft "C" compiler is needed for software development. The package requires a Microsoft "C" compiler, Version 4.0 and can be purchased from Tek or local Microsoft representative.

S58DC02 DCS/2467/2400 Series Scope GPIB Interface, S58DC04 DCS/11302 GPIB Interface

- Alters the scope's settings via the PC.
- Acquires waveforms, queries scope for scale factors, and computes calibrated waveform.

S58DC03 DCS Waveform Acquisition Module for SPD.

- Acquire Waveforms two ways:
  - Use the abbreviated DCS software contained in S58DC03, or
  - Use the full DCS software to convert the waveform file to the SPD format.

This package allows waveforms acquired by the DCS to be processed by Tek's Signal Processing and Display (SPD) program (Versions 1.1 or 2.0). All SPD functions such as FFT's, convolutions, correlations and waveform statistics can be used. Note: Because of the 640K limitations of DOS, SPD, S58DC02, S58DC04, and S58DC03 cannot be used at the same time. Only SPD and one of the software packages can be used at one time.

C1001 CAMERA

The C1001 camera can be used by itself along with a DX02 power supply/interface for documentation purposes (see photo). It can be fed into the HC01/2 video copiers for an instant hardcopy, or fed into a video tape recorder and played back into the DCS frame/store card.

INSTRUMENT COMPATIBILITY

Scope Compatibility

Use with scopes with either 7.2×9.0 cm or 8.0×10.0 cm CRT image areas.

Recommended MCP scopes:

- 2467 350 MHz Four-Channel Portable Oscilloscope.
- 11302 500 MHz Programmable Analog Oscilloscope with an 11A71 Single Channel Amplifier plug-in.
- 7104A 1 GHz Real-Time Oscilloscope with a 7B10 Time Base and 7A29 Dual Trace Amplifier plug-in.

Non-MCP Scopes:

- Works on scopes with P-31 or P-11 phosphors. Note: the DCS is not recommended for use with analog storage scopes when they are in the storage mode. Some displays may have "hot" spots which cause the DCS to produce distorted waveforms. When using the DCS on a dual-beam scope, be sure that both traces are on the CRT at the same time. If not, the camera's one-third second video frame may miss both traces.

Computer/Controller Compatibility

Tektronix has verified the operation of this hardware and software on IBM PC, PC XT, Portable PC, PC AT, COMPAQ and Tektronix PEP 301.

Required IBM PC Basis System:

- IBM PC, XT, AT or compatible, 512K bytes memory, MS-DOS version 2.1 or higher; 1 360K byte floppy disk; numerical co-processor chip (8087 for PC/XT, 80287 for AT); color graphics adapter PC Terminal card, black and white video monitor.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99.

The following hardware/software is required to use the optional software packages.

- IBM PC enhanced AT or compatible; 640K bytes memory, expanded memory, 20M byte hard disk; 80287 numerical co-processor chip; 360K byte floppy disk; MS-DOS version 3.1; communications interface card (GPIB); black and white video monitor; IBM CGA card or compatible*, PC graphic terminal.

The PEP 301 controller exceeds the hardware/software configuration needed to run the DCS.*

* The present DCS software runs only in the CGA mode. Most EGA cards will default to CGA mode. We recommend you test your PC system before purchasing a DCS.

CHARACTERISTICS

Electrical and camera characteristics are valid only if the camera is operating at an ambient temperature between 0 and 40°C.

DCS01

Digitizing Technique—Scan Converter.
System Writing Speed—MCP Scopes: To bandwidth of the scope (single shot and repetitive). Non-MCP Scopes: Single Shot—dependent on scope's photographic writing speed. Repetitive—to bandwidth of scope. Note: analog scope's photographic writing speed varies depending on the age of scope/CRT, phosphor, CRT filters, intensity, accelerating potential, etc. A good rule is that if you can see the entire waveform, then the DCS can probably capture it; if in doubt try it first.
Nominal Digitizing Resolution—12 bits repetitive, 8 or 9 bits single shot (baseline RMS is greater than 74 dB, S/N).
Record Length—512 points.
Number of Channels—1 (multiple channel software available free when registration card is sent in).
Signal Acquisition Rate (with IBM PC/AT)—Time to capture, digitize, and display on CRT is approximately 2 to 4 s. Time to capture and digitize one waveform is approximately 150 to 600 ms.
Maximum Number of Displayed Waveforms—6.
Number of Active Waveforms—26. Number of Stored Waveforms: (mass storage dependent).
Calibration Output Signal (Into 1 MΩ or 50 Ω)—Form: Square wave. Frequency: 20 kHz within 0.1%. Amplitude: 800 mV within 0.2%. Steps: Six 100 mV steps (within 0.2%).
Video Output Signal—NTSC standard, RS-170. (Either stored in memory or live from camera).
Oscilloscope Reset Signal—12 V pulse.
Power Requirements (includes camera & board)—Less than 16.5 W.
Power Requirements (board & camera)—+12 V supply: Less than 300 mA. −5 V supply: Less than 35 mA. +5 V supply: Less than 2.5 A.
Frame Store Board—Fits a full-slot in an IBM PC, approximately 13.25 in. (33.66 cm).

C1001 CAMERA

Focal Length—10.746 mm (at 5200 A).
F Number at Infinity—F/1.3.
Object-to-Image Distance—163.542 mm at 0.075X, 144.723 mm at 0.833X.
Field of View (Variable Mag.)—7.2×9.0 cm & 8.0×10.0 cm.
Spectral Range—400 to 600 nm within 3 dB.
Angular Range—23.45°.
Distortion—Within 0.3% (at image plane).
Lens Resolution—Center: 100 lines/mm, Edge: 20 lines/mm.
Imaging Device—Solid State, Inter-line CCD.
Pixels—490 Vertical by 384 Horizontal.
Resolution—Vertical: 480 Lines, Horizontal: 285 Lines.
S/N Ratio—Typical: 50 dB. Minimum: 47 dB. Gamma=1.
Sensitivity—3 Lux.
Video Output—1 V p-p. Composite Video. 75 Ω.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Weight	120	4.8
Height	104	4.1
Depth	241	9.5
Weight ≈	**kg**	**lb**
Net w/mounting adapter	1.4	3.0

DX02 POWER SUPPLY/INTERFACE

The DX02 can handle up to two cameras.
Output Per Camera—DC Voltage: 12 V ±5%; DC Current: 0 to 600 mA; Ripple Content: 1 mV RMS or less at 500 mA load; Video Out: 75 Ω feedthrough direct from the camera.
Line-Voltage Range—88 to 270 V (fuses need to be changed for 100 to 120 V, or 220 to 240 V operation).
Line Frequency—40 to 440 Hz.
Power Requirements—100 to 240 V, 24 W maximum.
Safety Certification—UL, CSA, and VDE.
Temperature—Nonoperating: −55 to 75°C ambient; Operating: 0 to 50°C ambient.
Humidity—Nonoperating: 60°C @ 90% relative humidity; Operating: 50°C @ 90% relative humidity.
Altitude—Nonoperating: 50,000 ft. (15 km); Operating: 15,000 ft. (4.5 km).
Electromagnetic Compatibility—Qualifies under test limits specified for VDE 0871, Class B, emissions requirement.

ORDERING INFORMATION

DCS01 Digitizing Camera System*1 **$5,500**
Includes: Camera, frame store board, software, DCS cable (174-0449-00), 3 BNC to SS cables (174-0430-00), operator manual (070-6157-00).

DCS01 OPTIONS

Option 1A—adapter for 7K, 5K Series scopes (016-0248-01). **+$85**
Option 2A—adapter for 2400 lines and 8×10 cm scopes (016-0269-03). **+$95**
Option 3A—adapter for 485 Series and 7×9 cm scopes (016-0306-01). **+$95**
Option 1C—GPIB Card for IBM PC.*2

C1001 Video Camera. Requires camera adapter bezel(s). Same options (1A, 2A, and 3A) as the DCS01. **+$2,800**
Includes: Camera, cable (174-0449-00); instruction manual.

C1001 OPTION

Option 4—DX02 Power Supply/Interface.*3 **NC**
Note: When ordering the C1001 with Option 04, please select one of the A0 through A5 power plug options. For example: A C1001 with Options 04 and A0 include a DX02 set for 120 V ac; A C1001 with Options 04 and A1 include a DX02 set for 240 V ac with Euro Plug.

DX01—DCS01 Frame/Store Board. **+$2,250**
Includes: Three SS to BNC cables, operator's manual.

DX01 OPTION

Option 01—DCS01 Operating Software. A C1001 and DX01 with Option 01 equals a DCS01. **+$600**

DX02—C1001 Camera power supply/interface (120 Version).*1

INTERNATIONAL POWER PLUG OPTIONS

Option A0—Standard North American 120 V, 60 Hz.
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

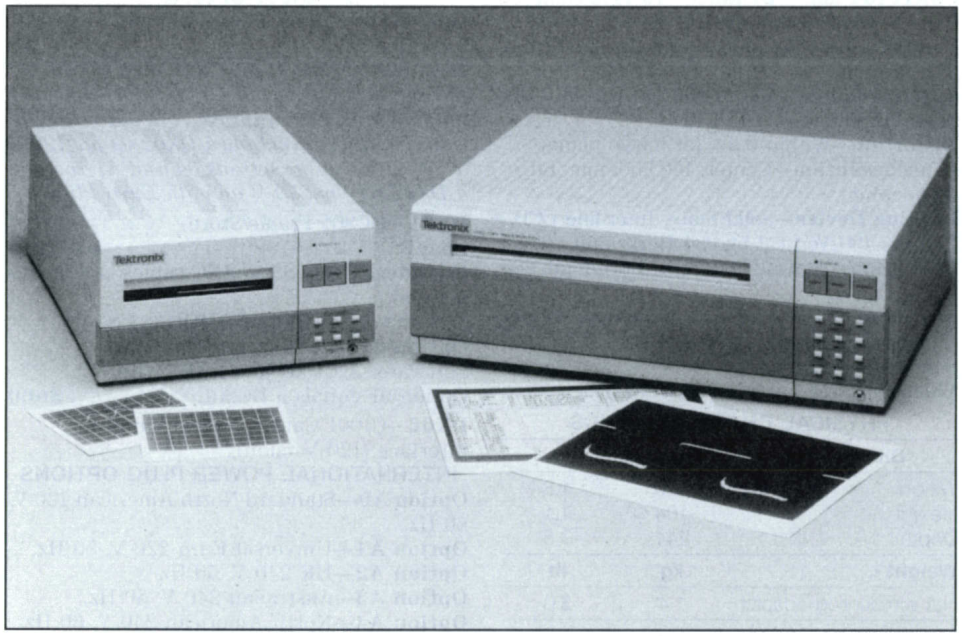
SOFTWARE

S58DC01—DCS01 functional library/source code. **$295**
Microsoft "C" Compiler—Version 4.0.*1
S58DC02—DCS/GPIB Interface for 2467.*3
S58DC03—DCS Waveform Acquisition Module for SPD™ (requires SPD Versions 1.1 or 2.0), see S3FG130).*3
S3FG130 Option 01—Signal Processing and Display software, Version 2.0. **$950**
S58DC04—DCS/GPIB Interface for 11302.*2

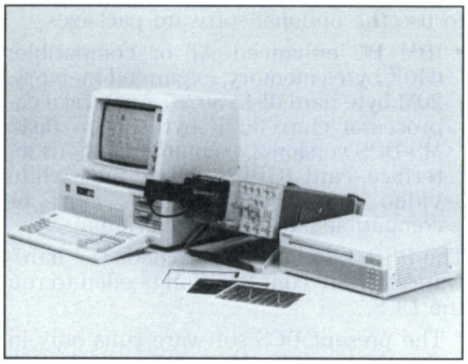
OPTIONAL INSTRUMENTATION

2467—350 MHz Portable Scope. See page 305. **$11,900**
7104—1 GHz Mainframe. See page 249. **$26,695**
11302—50 MHz Mainframe. See page 226. **$12,950**
HC01—4×5 inch Thermal Video Copier (110 V version). See page 478. **$995**
HC02—8×10 inch Thermal Video Copier (110 V version). See page 478. **$1,325**
Thermal Paper—four rolls per box.
(HC01) Order 016-0867-01. **$43**
(HC02) Order 016-0868-01. **$77**
Data Cable—These copiers require a PC-to-HC01/02 data cable (10 ft, male-to-male, 9-pin DB connectors). Order 174-0537-01. **$20**
PEP 301—System Controller. See page 392. **$7,995**

*1 *Requires camera adapter bezel(s) listed; one of each option can be ordered.*
*2 *Available January 1988.*
*3 *Contact your local Tektronix Sales Office.*



HC01/HC02 Video Copiers



HC02 Video Copier shown with DCS01 Digitizing Camera System and 2467 Oscilloscope.

HC01/HC02

Black and White Thermal Video Copiers

Applications: Imaging Products with Composite Video Outputs: Digitizing Camera System (DCS01, C1001); Logic Analyzers (except 1240 Series); Personal Computers (with CGA); VCR's; Medical Imaging; TV Camera; Ultrasound Systems; Manual Production; 7250 Digitizer

The HC01/HC02 offer copies in seconds (17 and 21 seconds, respectively) of the most complex computer-screen graphics (with CGA graphics card only) or TV/CRT display-monitor images. The copiers are ideal for a wide range of applications, such as permanent records of teleconferences, medical diagnostics, and measurement and instrumentation data.

CHARACTERISTICS

INPUT SIGNALS

NTSC/PAL/SECAM Composite Video—1 V p-p, 75-Ω terminated, negative sync (video bridged out).
RGB TTL From PC—TTL Level (bridged out), F (H) = 15.75 kHz.
Parallel Data Interface/Teletext/Videotex—TTL Level.

POWER REQUIREMENTS

Line Voltage—120 V ac ± 10%.
Line Frequency—50/60 Hz.
Power Consumption—HC01: 60 W. HC02: 110 W.

For A1–A5 Versions

Line Voltage—220/240 V ac ±10%.
Line Frequency—50 Hz.
Power Consumption—HC01: 60 W. HC02: 120 W.

PRINT SPECIFICATIONS

Paper—Super grade thermal type (black and white).

	HC01	HC02	
		Side Mode	Norm. Mode
≈ Prints/roll	180	75	94
Width	110 mm(4.3 in.)	216 mm (8.5 in.)	
Length	21 m (85 ft)	21 m (85 ft)	
Print Size	110×115 mm (4.3×4.1 in.)	216×279 mm (8.5×11 in.)	216×220 mm (8.5×8.6 in.)
Image Size	100×74 mm (3.9×2.9 in.)	200×148 mm (7.8×5.8 in.)	
Print Speed	≈17 s	≈21 s	

RESOLUTION (DOTS×LINES)

Composite Video Signal

	Frame Mode	Field Mode
NTSC	640×476	640×238
PAL/SECAM	640×512	640×289

RGB TTL Signal—
Field Mode: 640×200 (Noninterlace).
Frame Mode: 640×400 (Interlace).

Parallel Data—640 Dot 80 Column; ASCII 96 Character Built-in; Graphic Mode Application; Printing Speed 160 CH./s

Gray Scale—16 tones.

PHYSICAL CHARACTERISTICS

	HC01		HC02	
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	210	8.3	368	14.5
Height	112	4.4	119	4.7
Depth	358	14.1	337	13.3
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	5.5	12.1	7.7	17.0

ORDERING INFORMATION

Each copier includes a roll of thermal paper, 75-Ω cable, BNC to RCA cable, and a manual.
HC01 4×5 in. Video Copier.*1 **$995**
HC02 8×10 in. Video Copier.*1 **$1,325**

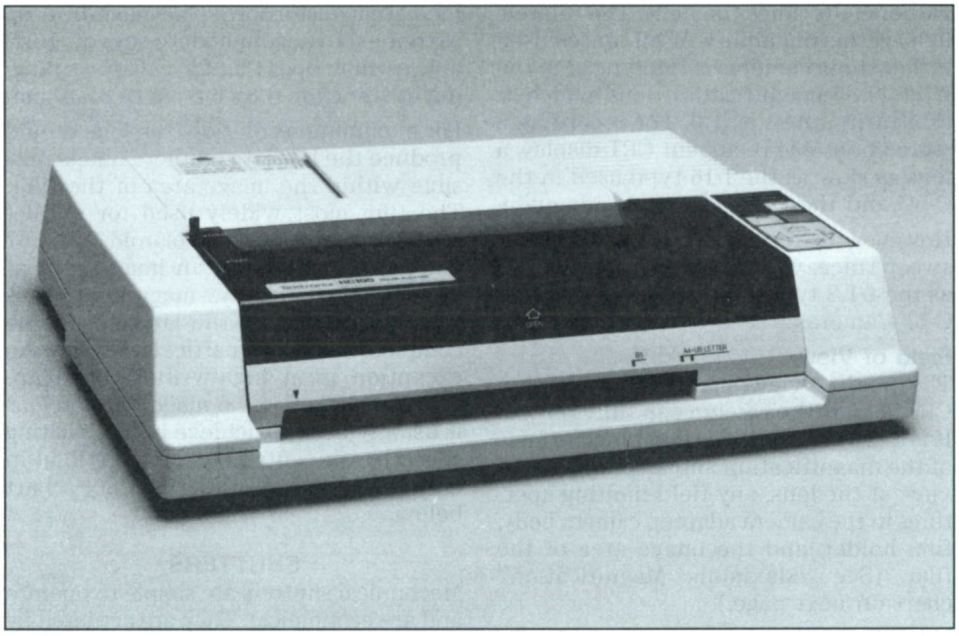
INTERNATIONAL POWER PLUG OPTIONS*2
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A5—Switzerland 220 V, 50 Hz.

*1 *110-V version.*
*2 *To get a 220/240 V version order one of the A1-A5 options. Units come in either 110 V or 220/240 V versions; power supplies are not interchangeable.*

OPTIONAL ACCESSORIES

Thermal Paper—Four rolls per box.
(HC01) Order 016-0867-01 **$43**
(HC02) Order 016-0868-01 **$77**
Data Cable—10 foot, male-to-male 9-PIN DB connectors. For connection to RGB TTL PC output.
Order 174-0537-01 **$20**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.



HC100 Plotter

HC100 Color Plotter

- **Compatibility*[1]: 2220/2221 Opt 10, 2230 Opt 10, 2430A (Version 1.8 Firmware or Above), 2430, 7854, 7D20, 336 Opt 01, 468 Opt 02, RTD 710 via GPIB; 370, 371 via Centronic**
- **Direct Plots from Many Tek Instruments without Using a Controller**
- **GPIB and Centronic Interfaces are Both Standard**
- **Can Be Used as a General Purpose Plotter By Using HPGL Command Set**
- **Four Color Pens in Three Styles**
- **Replaceable Pen Cartridge**
- **Compact Size**
- **Handles A4 and US Letter Size**

TYPICAL APPLICATIONS
Documentation from Digitally-Based Instruments
General Purpose Plotter for Hard Copies or Transparencies

The HC100 is a low-cost, four-pen, color plotter that is used for direct output of waveform plots and setup information from various Tek digitally-based instruments. It can be operated as a general purpose plotter, allowing mixed graphics and text, or as an Epson compatible printer. A full ASCII 96-character set is provided for text output. International character sets for 11 countries can also be selected.

Acquired waveforms in the instrument's digital memory, as well as the scope's setup conditions, are output directly to the HC100. Plot output is controlled from the instrument's front panel or keyboard. Up to six waveforms in X-T format (amplitude versus time) can be contained in a single plot, depending on instrument model and memory capacity.

The HC100 comes standard with both a GPIB and Centronic interface. Optional cables are available to attach the plotter to your instrument. Note: Only one interface at a time can be attached to an instrument. Otherwise, the HC100 may receive conflicting commands.

The HC100 is compatible with any instrument that uses Hewlett-Packard Graphics Language (HPGL). It operates in a manner similar to the HP 7470A plotter.

Both graphics and text can be printed in color. There are three types of pens used: Fiber-tip pens with water-based ink for paper, fiber-tip pens with oil-based ink for overhead projection film, and ball-point pens with water-based ink for paper. Ball point pens produce a finer line than a fiber pen. Pen sets have four colors: black, red, green, and blue and are available through Tektronix.

The HC100 pen cartridge holds four pens. The pens can be different colors, ink types, or point styles. The pen cartridge is easily changed allowing the user to quickly change colors or pen types. The plotter also has an automatic capping feature, which extends the life of the pens.

The HC100 is not recommended to be used with a GPIB instrument and external controller. The HC100 works best directly attached to the instrument to avoid handshake problems.

The HC100 is available in 120 V or 220/240 V versions. The power supply is not selectable. The HC100 comes in your choice of one of the power selections.

*[1] *Contact your local sales office for additional instrument compatibility.*

CHARACTERISTICS

Effective Drawing Size—267 mm (X-axis)× 192 mm (Y-axis).
Maximum Drawing Speed—230 mm/s (along pen axis).
Maximum Resolution—0.1 mm.
Pen Response Speed-15 times/s.
Number of Pens—4 (changed automatically).
Pen Types—Fiber pens: aqueous ink or oil-based ink. Ball-point pens: aqueous ink.
Pen Colors—Set of black, blue, red, and green.
Paper Sizes—ISO A4: 297×210 mm. B5: 257×182 mm. US letter size: 279×216 mm.
Paper Types—Ordinary paper; OHJ film.
Pen Movement Precision—Single Pen: 0.3 mm. Different Pens: 0.5 mm.
Pen Change Precision—Within 0.3 mm.

FUNCTIONS
Drawing Modes—Self Test, Plotter, Printer.
Character Types—ASCII (96 types); International (32 types for 11 countries).

POWER REQUIREMENTS
Line Voltage—Standard: 117 V ac ±10%. Options A1-A5: 220/240 V ac ±10%.
Line Frequency—49.5 to 60.5 Hz.
Power Consumption—30 W.

ENVIRONMENTAL
Temperature—Operating: +5 to +35°C. Nonoperating: +30 to +70°C.
Humidity—Operating and Nonoperating: 85%
Note: Operating and nonoperating ranges overlap.

RELIABILITY
Pen Lifetime—Aqueous fiber pen: ≈200 m. Oil-based Fiber Pen: ≈400 m. Aqueous ball-point pen: 400 m.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	415	16.5
Height	81	3.2
Depth	272	10.8
Weight ≈	**kg**	**lb**
Net	6	13.2

ORDERING INFORMATION

HC-100 Color Plotter. **$775**
Includes: 1 package of each pen set: Fiber tip/water based (016-0879-00); Fiber tip/oil based (016-0878-00); Ball point (016-0877-00); Operator's Manual; One pen cartridge (016-0876-00).

OPTIONS
Option 01—GPIB cable (012-0991-01).*[1]
Option 02—Centronic cable (012-1250-00).*[1]
To get a 220 V/240 V, 50 Hz version order one of these options.
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A5—Switzerland 220 V, 50 Hz.
(Example: An HC100 Option A1 will be a 220 V, 50 Hz Plotter with a universal Euro plug.)

OPTIONAL ACCESSORIES
Cables—
(1 m GPIB) Order 012-0991-01*[1]
(8 ft Centronic) Order 012-1250-00*[1]
Extra Pen Cartridge—
Order 016-0876-00 **$15**
Pens—Four colors in each package.
Fiber tip/aqueous ink. 016-0879-00 **$9**
Fiber tip/oil-based ink. 016-0878-00 **$9**
Ball point/aqueous ink. 016-0877-00 **$9**

*[1] *Contact your local sales office.*

CONTENTS

Reference 480
Camera and Adapter Selection Guide 483
C-5C 487
C-4 488
C-7 490
C-30 Series 492
C-50 Series 493
C-59A 494

A camera can be a key part of your measurement system. It allows you to capture single events and to document and communicate your results with clarity and credibility.

MOUNTING ADAPTERS

The camera and adapter selection guide indicates the recommended camera and appropriate adapters required for most Tektronix instruments. In some cases, adapters are available from Hewlett-Packard or other oscilloscope and CRT-based manufacturers to mount Tektronix cameras to their instruments.

VIEWING

The C-30 and C-50 Series are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The lightweight C-5C and C-7 can easily be removed to view the CRT or you can use the viewing door in the flash unit. C-5Cs and C-7s without a flash have a large lift-up viewing door in its place. The C-50 Series cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view.

GRATICULE LIGHTING

Most scopes have graticule illumination. For those that do not, an image of the graticule may be obtained by using the flash on the C-5C or C-7 Cameras, or a storage scope's background illumination (flood guns).

LENSES

Tektronix camera lenses differ mainly in speed (light-gathering ability), field of view, and magnification.

Speed

The f-number of a lens inversely signifies its aperture area and light-gathering ability. For example: the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light-gathering ability of all lenses used in Tektronix cameras is referenced to the f/1.9, 0.85-magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C and the C-7 Cameras is adequate.

However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

Field of View

The field of view signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adapter, camera body, film holder, and the image area of the film. (See "Maximum Magnification" chart on next page.)

Magnification

The rated magnification of a lens signifies its image-to-object ratio. For example, if a lens has a magnification of 0.85, then for every square centimeter on the CRT face the camera would record 0.85 square centimeter of image on the film.

Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed-focal-length lenses must be used at their design-center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. Most Tektronix cameras are designed for use at one lens magnification. One exception is the C-30B Camera, which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8×6.3 cm to 8×10 cm.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope-trace recording is Polaroid Type 667 pack film, which has an image area of 73×95 mm. Usually, magnification is selected to provide the largest possible complete image of a particular display. An exception is in high-writing-speed applications where a 0.5-magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film. See chart below.

SHUTTERS

Mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism. Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

POWER REQUIREMENTS

The C-5C uses four AA alkaline batteries.

The C-7 has three choices of power available: battery pack utilizing eight AA alkaline batteries; ac power supply; or external remote power.

The C-51 and C-53 electric shutters require +15 volts, normally supplied by a 7000-Series oscilloscope. An optional battery pack (016-0270-02) is available for situations where one of these cameras is used on a non-7000-Series instrument. These shutters can be actuated by a switch closure to ground. The C-59A has internal batteries or uses power from the 7000-Series mainframe.

MAXIMUM MAGNIFICATION NEEDED TO RECORD ENTIRE SCREEN

Screen Size	5×6.3 cm	7.2×9 cm	8×10 cm	9.76×12.2 cm
Polaroid 3¼× 4¼-in. pack and roll film	1.0	1.0	0.85*1	0.67*1
4×5 in. films	1.0	1.0	1.0	0.85 or less
6×7 cm format roll film (70 mm, 120 mm, 220 mm, etc.)	1.0	0.67	0.67	Not recommended

*1 *Preferred magnification ratio for the screen size and to fill most of the usable image area of the film type.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

FILMS

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivities of various film types. Wet process, roll, or cut films can be used if the proper back is selected. (See the respective camera for optional backs.)

Selected Polaroid films are available through Tek. Technical assistance with Polaroid film and back questions or problems is available directly from the Polaroid Corporation. Call 1-800-343-5000 toll free within the U.S.

FILM BACKS

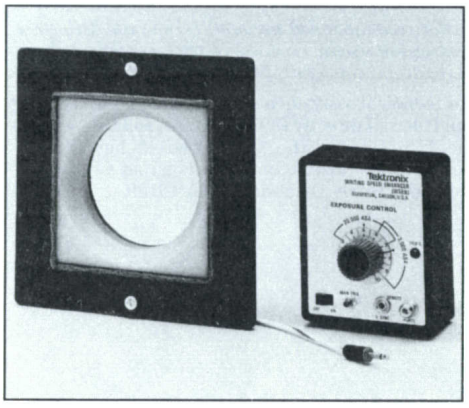
There is a wide variety of cameras and backs. Backs within a series are interchangeable. See the specific camera for information on a particular back.

PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.

Increasing Writing Speed

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The Tektronix Writing Speed Enhancer (WSEN) is designed to fill this need.



WSEN (Writing Speed Enhancer) diffuser with control box.

STANDARD AND OPTIONAL FILM BACKS AND HOLDERS AVAILABLE FROM TEK

Tek Modified Polaroid Backs	C-30 Series	C-50 Series	C-4, C-5C, C-7
3¼×4¼-in. pack	Std on "P" models	Std on "P" models	Noninter-changeable (C-5C & C-4)
Roll*1	Yes*1	Yes*1	NA
4×3-in. AutoFilm	NA	NA	C-7 only
Graflok-Type*2 Interface	Optional*2 Back	Std on*2 "G" models	NA
Polaroid 3¼×4¼-in. pack holder	Yes	Yes	
Polaroid 4×5-in.single-sheet holder	Yes	Yes	
Polaroid 4×5-in. pack holder*3	*3	*3	
120-mm roll	Yes	Yes	
70-mm roll	Yes	Yes	
4×5-in. cut film holder*4	*4	*4	

*1 *Polaroid is gradually reducing the number of its roll films. Replacement roll backs are available in limited quantities from Tektronix.*
*2 *Requires one of the film holders listed in order to be usable.*
*3 *Will work but available only from Polaroid.*
*4 *Will work but not available from Tek, see your local camera store.*

The enhancer installs in minutes, and can be triggered in three ways: by a push-button on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x-sync switch); or by the oscilloscope-sweep +gate. The WSEN is powered by two 9-V batteries (not included), which are inside the control box.

The film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, postfogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the enhancer with the oscilloscope-sweep +gate.

For more information on photographing high-speed signals, request Application Note 42-W-5335-1.

Polaroid Film		Relative Film Writing Speed	
ASA Equivalent Speed	Type	Unfogged	Fogged
3,000	667, 107, 084, 47	1 (Reference)	3*1
20,000	612	>2	>3.5

*1 *Value depends on film, scope, CRT, camera, and the operator.*

COMMONLY USED POLAROID FILMS

Shaded text indicates films available through Tektronix.*5

Film Type	ASA Equivalent Speed	Development Time (seconds at 75°F)	Format	Resolution	Characteristics	CRT Recording Uses: Repetitive	Stored	Single Sweep	Video Display	Scintillation Type Display	Color Displays	Scanning Electron Microscope
3¼×4¼-in. Pack Films—Actual image area 7.3×9.5 cm (2⅞×3¾-in.), 8 prints per pack												
611*1	200	45	PP	20	Low Contrast, Wide Gray Scale				✓	✓		●
612*5	20,000	30	PP	20 to 25	High Contrast			✓				
665*4	75	30	N PP	160 to 180 14 to 20	Medium Contrast, Wide Gray Scale	●*4	●*4		●*4			✓
107	3000	15	PP	16 to 20	Medium Contrast	●	●	●	●			
084	3000	15	PP	16 to 22	Medium Contrast	●	✓		●	✓		
667*1*5	3000	30	PP	11 to 14	Medium Contrast, coaterless	✓	✓	●	●	✓		✓
669*5	80	60	CP	11 to 14	Balanced for Color—Electronic Flash	●			●		✓	
691*5	80	4 min	CT		Includes Mounts	●			●	●	✓	
AutoFilm (For C-7 only)—Actual image area 10×7.5 cm (4×3 in.), 10 prints per pack												
331*1*3*5	400	60	PP	20	Medium Contrast, Extended Gray Scale	●	●		✓	✓		✓
336*1	100	60	NT	40 to 100	Medium Contrast, High Resolution				✓			●
339*1*2*5	640	>60	CP*2	7 to 9	Medium Contrast, High Speed Color				●*2		✓*2	
4×5 Films—Actual image area 9.0×11.4 cm (3½×4½-in.)												
55			PP	22 to 25								
55 P/N	50	20	N	150 to 160	Medium Contrast, Wide Gray Scale	●	●		●			
57	3000	15	PP	16 to 20	Medium Contrast	✓	✓	●	●			
553 (8 Pack)	800	30	PP	16 to 22	Medium Contrast	●	●		✓			✓

Polaroid Roll Film Backs are no longer available from Tektronix on new cameras. Polaroid still manufactures some roll films. . . Call their toll free number 1-800-343-5000 for roll film availability.

✓ *Preferred film for application.*
● *Acceptable performance.*
*1 *No coating required.*
*2 *Requires electronic scan reversal to yield a correct reading image.*
*3 *Seconds at 75°F.*
*3 *Similar to Type 611.*
*4 *Allow prints to be made from negative; good for documentation or publications.*
*5 *Available from Tektronix. See right.*
PP=*Positive Print*
N =*Negative*
CP=*Color Positive Print*
CT=*Color Transparency*
NT=*Negative Transparency*

POLAROID PACK FILMS AVAILABLE FROM TEKTRONIX

Recommended for all cameras with a Polaroid 3¼×4¼ inch Pack Back.

Type 667—B&W print, no coating required (3,000 ASA). (3 twin packs) 48 prints. Order 006-6824-00 **$42**
(25 twin packs) 400 prints. Order 006-6824-00 **$350**

Type 612—B&W print, high contrast (20,000 ASA). (3 single packs) 24 prints. Order 006-6822-00 **$35**
(50 single packs) 400 prints. Order 006-6823-00 **$580**

Type 669—Color print (80 ASA). (3 twin packs) 48 prints. Order 006-6826-00 **$63**
(25 twin packs) 400 prints. Order 006-6827-00 **$515**

Type 691—Color transparency with mounts, (80 ASA). (3 single packs) 24 trans. Order 006-6845-01 **$39**
(50 single packs) 400 trans. Order 006-6845-02 **$655**

Polaroid AutoFilm (C-7 only).

Type 331—B&W print, with extended gray scale (400 ASA).
(3 twin packs) 60 prints. Order 006-6815-00 **$58**
(10 twin packs) 200 prints. Order 006-6816-00 **$190**

Type 339*1—Color print (640 ASA). (3 twin packs) 60 prints. Order 006-6813-00 **$71**
(10 twin packs) 200 prints. Order 006-6814-00 **$220**

*1 *Not recommended for oscilloscope use. Requires electronic scan reversal of CRT to yield correct reading image on print.*

For technical assistance on Polaroid films and backs call Polaroid directly (800) 343-5000 toll free within the U.S. Outside the U.S., Polaroid has Service Centers and Offices, or write Polaroid Corp., 784 Memorial Drive, Cambridge, MA 02139.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

CAMERA SELECTION GUIDE

Camera	C-51	C-53	C-59A	C-30B	C-31B	C-5C	C-4	C-7
Features	Fastest writing speed Adjustable film and shutter speed Built-in view port Remote shutter actuation Interchangeable film backs Single-sweep mode	General purpose for instruments with 8×10 cm CRTs Adjustable film and shutter speed Built-in view port Remote shutter actuation Interchangeable film backs Single-sweep mode	General purpose for CRTs up to 6½ inches; low cost Adjustable film and shutter speed Built-in view port Internal batteries Interchangeable film backs OEM pricing available	Continuously variable magnification Dual swing-away hinge for viewing the CRT Easy operation Interchangeable film backs Compact size OEM pricing available	Max writing speed for portable scopes Dual swing-away hinge for viewing the CRT Easy operation Interchangeable film backs Compact size	Low cost, mounts on most scopes Graticule illuminator Viewing door Easy to use Fixed focus OEM pricing available	Lowest price Tek camera, hand held Easily interchangeable hoods Scope and video hoods Easy to use Fixed focus OEM pricing available	Motorized film back Auto developing prints; uses Polaroid AutoFilms Audible indicators Remote shutter activation Fixed focus OEM pricing available
Lens Apertures	f/1.2 to f/11	f/1.9 to f/16	f/2.8 to f/16	f/1.9 to f/16	f/1.3 to f/16	f/16 fixed	f/4.5 to f/32	f/16 fixed
Magnification	0.5	0.85	0.67	Variable: 0.7 to 1.5 (0.8 with Opt 01)	0.5 (0.43 with Opt 01)	0.67 or 0.85	0.80, 0.70, 0.85 depending on hood	0.67 or 0.85
Relative light gathering	3.0	1.0	0.65	1.0 (0.9 with Opt 01)	2.7 (2.9 with Opt 01)	0.02	0.14 (0.85 mag) 0.18 (0.70 mag)	0.02
Field of view with Polaroid pack (cm)	8×10		10.2×12.7	8×10 (Opt 01); 7×9 (std)		9.8×12.2 or 8×10	9.1×11.87 (std) 10.4×13.5 (Opt 02) 8×10 (Opt 03)	8.1×10.7 (0.85 mag) 10.3×13.8 (0.67 mag)
Resolving Power: at center: (lines/mm)	30 or better		10 or better	at 1:1 25 or better	30 or better	6 or better		
Resolving Power: at corners: (lines/mm)	15 or better		4 or better	10 or better	15 or better	3 or better		
Shutter Type	Electrical, 1/60 to 4 s (bulb, time, single sweep), remote shutter actuation, x-sync, scope "+gate" input		Mechanical, 1/125 to 1 s (bulb and time) x-sync			Electrical, 1/10 to 5 s, (Time Mode)	Mechanical, 1/125 to 1 s (bulb), x-sync	Electronic actuated 1/10 to 5 s, (Time Mode)
Film backs	Polaroid pack standard with "P" models, Graflok back standard with "G" models			Polaroid pack standard with "P" models, Graflok back available (016-0487-00)		Polaroid pack noninterchangeable		Polaroid AutoFilm noninterchangeable (CB-33)
Recommended films (see page 486 for ordering	612 667	667 612 691	667 669 691	667 612 669 691	612 667	667 669 691	667 669 691	AutoFilm Only 331 339
Options	Opt 11 corrector lens for 11301 Opt 12 corrector lens for 11302	Opt 11 corrector lens for 11302	Opt 11 corrector lens for 11301/2	01 Provides the correct adaptor (016-0269-03) for Tek portables with 8×10 cm displays. Also includes a corrector lens for optical correction		See page 487 for specific selections of options	01 (0.8 mag) 02 (0.7 mag) 03 (0.85 mag) 10 (7.2 in diagonal) 11 (8.3 in diagonal) 12 (12.5 in diagonal) See C-4 description	See C-7 description for specific selections
Optional Accessories	Mounting adaptors, battery pack (for C-51, C-53), writing speed enhancer (one for each model), Polaroid pack film back, Graflok 4×5 in. back and film holders, x-sync connector, carrying case, foot switch (for C-51 and C-53)			Mounting adaptors, writing speed enhancer, Polaroid pack film back, Graflok 4×5 in. back and film holders, and carrying case; x-sync cable, portra lens (for C-30B only)		Mounting hood adaptors, flash unit, viewing door	Scope and video adaptor hoods, color filter kit (122-0909-00)	Film, foot switch, mounting hood adaptors, flash unit, battery pack, 110 V ac power supply
Page	493/494	493/494	494/495	492	492	487	488	490
Prices begin at	$2,410	$1,990	$1,375	$1,500	$1,775	$495	$375	$595

CAMERA AND MOUNTING-ADAPTER SELECTION GUIDE

Where two or more cameras are recommended, compare features and specifications to optimize for your application. Tek cameras fit many non-Tek CRT-based products. Contact your Tek Sales Representative for more information.

Oscilloscope or Display Device	Recommended Cameras			Mounting Adapter Part Numbers			
	High Writing Rate	General Purpose	Low Cost	C-4*11	C-5C, C-7	C-51, C-53, C-59A, C-27, C-28	C-30BP*13, C-31BP*13
11000 Series							
11301	C-51 Opt 11	C-59A Opt 11	C-5C; C-7	NR	016-0357-01	016-0249-06	NR
11302	C-51 Opt 12	C-53 Opt 11		NR	NR	016-0249-06	NR
11401 11402			C-4 Opt 10	122-0897-01	NR	NR	NR
5000 Series							
5100 Series Nonstorage*1*3; i.e., 5110, 5112, D10, D12, 577/D1, 5116*6		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01 016-0357-01	016-0249-06	NR
5100 Series Storage*1*2; i.e., 5111, 5111A, 5113, 5115, D11, D13, D15, 577/D2		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	NR
5400 Series Nonstorage*1*2; i.e., 5403/D40, 5440, 5444, D40		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	NR
5400 Series Storage*2*4; i.e., 5403/D41, 5441, D41	C-51	C-53	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
5223*1		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	NR
7000 Series							
8×10 cm Display; i.e., 7104, 7503, R7103, 7504, 7514, 7613N, 7623, 7633, 7704(A), 7834, 7844, 7854, 7934, R7903, 7904, 7904A, T922R*2	C-51 C-31BP Opt 01*10*13	C-53 C-30BP Opt 01*10*13	C-4 Opt 02 C-5C C-5C Opt 01 C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
Large Screen Display*1; i.e., 7403, 7603, 7603N		C59A	C-4 Opt 02 C-5C C-5C Opt 01 C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	NR
Portables							
Older with 0.8-cm Graticule*5; i.e., 422, 453, 454, 485, 491	C-31BP	C-30BP	C-4*4	122-0894-01	No adapter	No adapter*5	016-0306-01
Newer with 1-cm Graticule*5; i.e., 2235, 2245, 2246 Option 01; 2400 Series, 455, 464, 465, 465B, 465M, 466, 468, R468, 475, 475A, 432, 434, 442	C-31BP*7 Opt 01	C-30BP*7 Opt 01	C-4; C-5C Opt 02 C-5C Opt 04 C-7 Opt 02 C-7 Opt 03	122-0894-01	016-0359-01	No adapter*5	016-0269-03
1-cm Nonilluminated Graticule*5; 2213(A), 2215(A), 2220/21, 2225, 2230, 2235, 2236			C-7 Opt 02 C-5C Opt 04	NR	016-0359-01	No adapter*5	016-0269-03
¼-inch Graticule*4*5*12; i.e., 305, 314, 326, 335, 336, 1501, 1502		C-30BP Opt 01*10	C-4 Opt 03*4	122-0896-01	No adapter	No adapter*5	016-0327-01
TM 500*5; i.e., SC 502, SC 503, SC 504*4		C-30BP Opt 01*10		NR	No adapter	No adapter*5	016-0327-01
Nonilluminated Graticule*5*8; 2335, 2336, 2336YA, 2337			C-5C Opt 04*8 C-7 Opt 02*8	NR	016-0359-01	No adapter*5	No adapter

continued on next page

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

CAMERA AND MOUNTING-ADAPTER SELECTION GUIDE

Where two or more cameras are recommended, compare features and specifications to optimize for your application. Tek cameras fit many non-Tek CRT-based products. Contact your Tek Sales Representative for more information.

	Recommended Cameras			Mounting Adapter Part Numbers			
Oscilloscope or Display Device	**High Writing Rate**	**General Purpose**	**Low Cost**	**C-4*11**	**C-5C, C-7**	**C-51, C-53, C-59A, C-27, C-28**	**C-30BP*13, C-31BP*13**
Display Monitors							
8×10 cm*3; i.e., 601, 602, 605, 606, 606B, 607		C-30BP Opt 01*10 C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
Large Screen 10 × 12 cm*1; i.e., 603, 604, 608, 620, 624, 634		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	NR
Older 5 Inch Round*2							
502, 503, 504, 515, 516, 519, 530/540/550/580 Series, 575	C-51*2*10	C-53*2*10	C-59A*10	NR	No adapter	016-0225-04	016-0243-00
Older 5 Inch Rectangular							
560 Series*2; i.e., 561, 564, 567, 568		C-53*2*10	C-59A*10	NR	No adapter	016-0224-01	016-0244-00
Television Products							
380, 381		C-30BP Opt 01*10	C-4 Opt 03	122-0896-01	No adapter	No adapter	016-0327-01
520, 520A, 521, 521A, 522A*1*2		C-59A*10		NR	No adapter	016-0295-01	No adapter
1480C		C-53*2*10	C-59A*9*10	NR	No adapter	016-0342-00*9	No adapter
528A*2, 1420, 1421, 1422, 1424*1*2		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
529*1		C-53*10				016-0224-01	
1705, 1710B, 1711B, 1720/21, 1730/31, 1740, 1741, 1742, 1750, WFM300		C-30BP Opt 01*15	C-4 C-5C Opt 02 C-5C Opt 04 C-7 Opt 02 C-7 Opt 03	122-0894-01	016-0359-01	No adapter*5	016-0269-03*15
Spectrum Analyzers							
2710		C-30BP Opt 01	C-5C Opt 04 C-7 Opt 02	NR	016-0359-01	No adapter	016-0269-03
491*5		C-30BP		NR	No adapter	No adapter*5	016-0306-01
492A, 492P, 494, 494P, 495, 496, 496P*2, 2754/55/P		C-59A	C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
Other Products							
370, 371		C-59A	C-4 Opt 02 C-5C C-7	122-0895-01	016-0357-01	016-0249-06	NR
576, 5030, 5031		Only C-59(A)*10		NR	No adapter	016-0288-01 [C-59(A) only]	No adapter
OF150, OF151, OF152, OF235 TDR			C-4 Opt 02 C-5C C-7 C-7 Opt 01	122-0895-01	016-0357-01	NR	NR
1240*8*14			C-4 Opt 11	122-0898-01	NR	NR	NR
T900 Series, excluding T922R (see 7000 Series)			C-5C Opt 03 C-7 Opt 04	NR	016-0358-01	No adapter*5	No adapter
308			C-4 Opt 03	122-0896-01	NR	NR	NR

*1 *Only cameras with <0.7 magnification can record the entire screen area of a 10×12 cm display.*
*2 *These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.*
*3 *These scopes require modification for graticule illumination.*
*4 *Though these scopes do not have illuminated graticules, the graticule may be photographed using storage flood guns on storage models.*
*5 *Due to physical configuration, the C-50 Family cannot be mounted.*
*6 *The C-7 can only be used for color if the image is electronically reversed.*
*7 *A corrector lens is required to increase cameras field of view so that the full 8×10-cm CRT display area can be recorded. The camera should be changed from standard to Option 01. To do this, order 016-0301-01 for the standard C-30B or 016-0269-04 for the standard C-31B. These kits include the mounting adapter and corrector lens.*
*8 *These scopes have no CRT bezel; therefore, a camera cannot be mounted. A hand held C-5C, C-7, or C-4 can obtain a record.*
*9 *The C-59A may be used with 016-0224-01, however the image size is reduced.*
*10 *Adapter not included with camera. Order adapter separately.*
*11 *Use on scopes with graticule illumination or bistable storage.*
*12 *Scopes do not have graticule illumination.*
*13 *C-30 Series may cut off the first and last small graticule "tick" marks on some scopes.*
*14 *Must use f/22 or f/32 to get enough depth of field for good focus.*
*15 *C-30 Series will not fit models 1740, 1741, 1742, 1750, and WFM300.*
NR=*Not recommended*

ORDERING INFORMATION

CAMERA MOUNTING ADAPTER AND HOOD

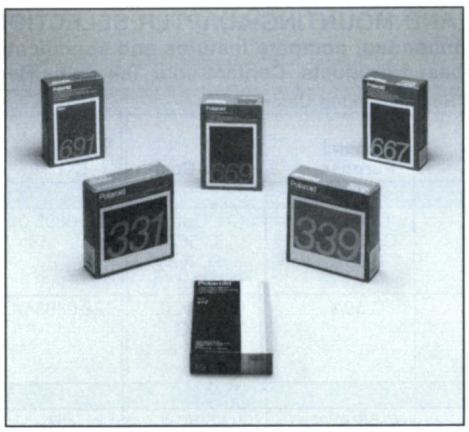
016-0217-00	$115	016-0295-01	$90
016-0224-01	$120	016-0299-00	$100
016-0225-04	$90	016-0301-01*3	$115
016-0226-01	$85	016-0306-01*4	$100
016-0228-01	$120	016-0327-01	$175
016-0243-00	$95	016-0342-00	$235
016-0244-00	$110	016-0357-01*5	$20
016-0248-01	$95	016-0358-01*6	$20
016-0249-06*1	$105	016-0359-01*7	$21
016-0263-00	$100	122-0894-01*8	$45
016-0269-03	$115	122-0896-01*9	$55
016-0269-04*2	$110		

*1 *Included with C-50 Series Cameras.*
*2 *Adapter and lens included with C-31B Option 01 Cameras.*
*3 *Adapter and lens kit included with C-30B Option 01 Cameras.*
*4 *Included with Standard C-30B, C-31B Cameras.*
*5 *Included with C-5C and C-5C Option 01 Cameras.*
*6 *Included with C-5C Option 03 Cameras.*
*7 *Included with C-5C Option 02 and Option 04 Cameras.*
*8 *Included with C-4 (Standard).*
*9 *Included with C-4 Opt 02 and Opt 03.*

POLAROID REPLACEMENT ROLLER ASSEMBLIES FOR PACK FILM BACKS

(Gray) Order 401-0304-00 $31
(Red and Black) Order 401-0303-00 $26

Note: Because of mechanical differences, both roller assemblies are incompatible with each other's back.



POLAROID PACK FILMS AVAILABLE FROM TEKTRONIX

Recommended for all cameras with a Polaroid 3¼×4¼ in. Pack Back.

Type 667—B&W print, no coating required (3,000) ASA). (3 twin packs) 48 prints. Order 006-6824-00 $42
(25 twin packs) 400 prints. Order 006-6825-00 $350

Type 612—B&W print, high contrast (20,000 ASA). (3 single packs) 24 prints. Order 006-6822-00 $35
(50 single packs) 400 prints. Order 006-6823-00 $580

Type 669—Color print (80 ASA). (3 twin packs) 48 prints. Order 006-6826-00 $63
(25 twin packs) 400 prints. Order 006-6827-00 $515

Type 691—Color transparency with mounts, (80 ASA). (3 single packs) 24 trans. Order 006-6845-01 $39
(50 single packs) 400 trans. Order 006-6845-02 $655

Polaroid AutoFilm (C-7 only).
Type 331—B&W print, with extended gray scale (400 ASA). (3 twin packs) 60 prints. Order 006-6815-00 $58
(10 twin packs) 200 prints. Order 006-6816-00 $190

Type 339*1—Color print (640 ASA) (3 twin packs) 60 prints. Order 006-6813-00 $71
(10 twin packs) 200 prints. Order 006-6814-00 $220

*1 *Not recommended for oscilloscope use. Requires electronic scan reversal of CRT to yield correct reading image on print.*

For technical assistance on Polaroid films and backs call Polaroid directly (800) 343-5000 toll free within the U.S. Outside the U.S., Polaroid has Service Centers and Offices, or write Polaroid Corp., 784 Memorial Drive, Cambridge, MA 02139.

ACCESSORIES FOR OLDER TEKTRONIX CAMERAS

Polaroid Pack Film Back for Older Cameras: C-12, C-19, C-13, C-27
The Pack Film Back accepts the Polaroid pack film. (3¼×4¼ in.).
Order 122-0671-01 $295

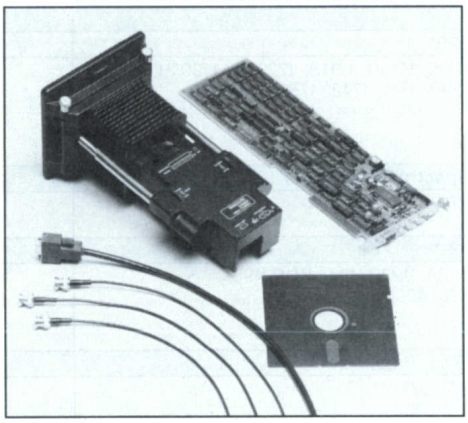
Mounting Adapters for C-12—C-12 to 7000 Series and 5000 Series.
Order 016-0299-00 $100
C-12 to 530, 540, 550 Series.
Order 016-0226-01 $85
C-12 to 560 Series rectangular CRTs.
Order 016-0217-00 $115

Writing Speed Enhancer—For C-12, C-27. Provides controlled film fogging to increase writing speed by 3× for 3,000 ASA film and >3.5× with 20,000 ASA film. Installs in minutes. Order 016-0280-02 $380

Carrying Case—For C-12, C-27.
Order 016-0208-01*1

*1 *Contact your local Sales Office.*

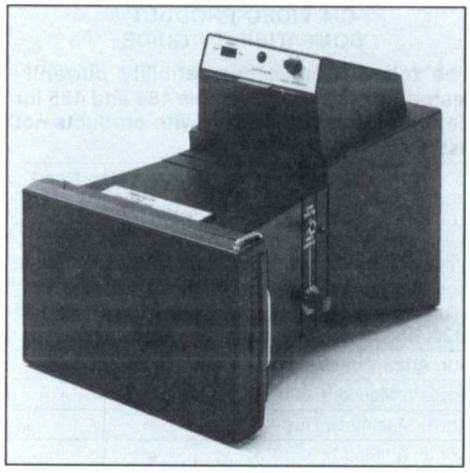
DIGITIZING CAMERA SYSTEM



DCS01

The DCS01 Digitizing Camera System combines CCD technology with an IBM PC, XT, AT, or compatible to acquire and digitize repetitive and transient waveforms displayed on oscilloscopes, spectrum analyzers, and other displays. Used with scopes having the microchannel plate CRT, such as the 7104, 11302, and 2467, the DCS01 can acquire repetitive and transient signals at the full bandwidth of the scope. With other scopes, the DCS01 will acquire repetitive events at the full scope bandwidth and transient events according to the photographic writing rate of the oscilloscope. Refer to page 476 for additional information.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.



Standard C-5C (with flash).

C-5C

- **Low Cost**
- **Easy to Use**
- **Mounts Onto Many Scopes and CRT-Based Instruments**
- **Covers 8×10-cm or 9.8×12.2-cm CRT Displays**
- **Fixed Focus**
- **Lightweight and Compact**
- **Interchangeable Adapter Hoods**
- **Built-In Flash on Some Models**
- **OEM Pricing Available**

Maximum Performance at Minimum Cost

If your application does not require specialized photographic techniques, such as the capability to record single sweeps, this general-purpose camera may fill your needs at a low cost. The C-5C is lightweight and modular, with a reliable electronically activated shutter. The three-element f/16 lens offers both 0.67 and 0.85 magnifications, either of which you can easily change by reversing the lens/shutter module and the spacer module positions.

Flash

A variable-intensity xenon flash that evenly lights CRTs with nonilluminated graticules comes on the C-5C and Options 03 and 04. It can be easily retrofitted on C-5Cs that do not have it.

Viewing Door

Flash models have a small built-in door. Nonflash models replace the flash unit with a large lift-up viewing door (016-0630-00).

Adapter Hoods

Comes standard with camera (see below), and additional hoods can be ordered separately. Easily changed by removing four screws inside hood.

Film

Uses Polaroid 3¼×4¼ inch pack film; i.e., 667, 665, etc. See page 482 for other films.

CHARACTERISTICS

Aperture—Fixed at f/16.
Lens—Three glass elements.
Magnification—0.67 or 0.85.
Relative Light-Gathering Ability—0.02.
Shutter—Electronic; 1/10 to 5 s; time.
Field of View—9.8×12.2 cm (0.67 magnification) or 8.0×10.0 cm (0.85 magnification).
Power—The C-5C requires (4) AA alkaline batteries (not included). Battery holder inside camera.

PHYSICAL CHARACTERISTICS*1

Dimensions	mm	in.
Width	168	6.6
Height	140	5.5
Depth	257	10.1
Weights ≈	**kg**	**lb**
Net	1.4	3.0
Shipping	1.9	4.1

*1 *Standard C-5C.*

The C-5C and C-7 are separate camera systems; therefore, a C-5C cannot be converted into a C-7 and vice versa. However, they do use the same hoods and flash assemblies.

ORDERING INFORMATION

Camera includes one hood. Additional hoods purchased separately, see below.

C-5C Camera — **$495**

Includes: Adapter hood (016-0357-01); flash unit (016-0642-02); battery holder, instruction manual (070-2824-00).

OPTIONS

Option 01—016-0357-01 adapter hood, no flash. — **– $30**
Option 02—016-0359-01 adapter hood, no flash. — **– $30**
Option 03—016-0358-01 adapter hood with flash. — **NC**
Option 04—016-0359-01 adapter hood with flash. — **NC**

OPTIONAL ACCESSORIES

For ordering films see page 482.

Large Viewing Door—Fits all three mounting adapter hoods. (Included with C-5C Options 01 and 02.)
Order 016-0630-00 — **$8**

Graticule Flash Unit—Fits all three mounting adapter hoods. (Included with C-5C and C-5C Options 03 and 04.) Order 016-0642-02 — **$160**

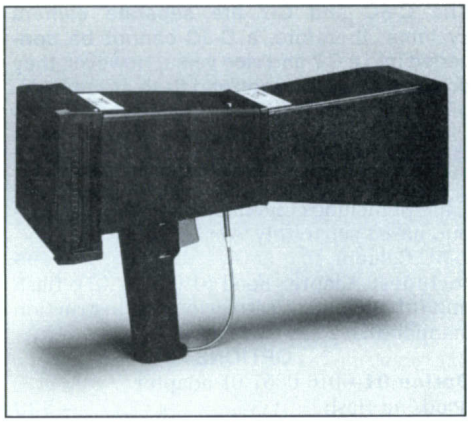
Additional Mounting Adapter Hoods—
Requires flash unit or large viewing door.
(C-5C and C-5C Option 01)
Order 016-0357-01 — **$20**
(C-5C Options 02 and 04)
Order 016-0359-01 — **$21**
(C-5C Option 03)
Order 016-0358-01 — **$20**

Special pricing, terms, and conditions are available to qualified OEMs. Contact your local Tektronix Sales Engineer for complete information.

C-5C SELECTION GUIDE

Features	Standard		Option 01		Option 02		Option 03		Option 04	
Flash Unit	✓						✓		✓	
Large Viewing Door			✓		✓					
Adapter Hood	016-0357-01		016-0357-01		016-0359-01		016-0358-01		016-0359-01	
Hood Dimensions*1	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**
Height										
Inside	13.0	5.13	13.0	5.13	10.5	4.13	9.5	3.74	10.5	4.13
Outside	13.7	5.38	13.7	5.38	11.2	4.40	11.2	4.41	11.2	4.40
Width										
Inside	14.2	5.60	14.2	5.60	12.0	4.74	11.8	4.65	12.0	4.74
Outside	14.9	5.85	14.9	5.85	12.7	4.99	13.1	5.14	12.7	4.99
Compatibility	577, 600 Series with nonilluminated graticule, 1420 Series, 5100 Series		528, 600 Series without graticule or with illuminated graticule, 5400 Series, 7000 Series, T922R, 370		432, 434, 455, 464, 465B, 465M, 466, 468, 475, 475A, 2245, 2246, 2400 Series		T900 Series (except T922R)		2200 Series with nonilluminated graticule 2710	

*1 *All dimensions are approximate since each hood has additional plastic notches and grooves for mounting.*



Standard C-4 Hand-Held Camera.

C-4

- **Hand-Held Operation**
- **No Focusing Required**
- **Four Element f/4.5 Glass Lens System**
- **Mechanical Shutter**
- **Adapts to Most Tektronix and Non-Tektronix Scopes and CRT Displays**
- **Five Easily Interchangeable Scope Hoods**
- **Three Large Hoods for Video Screens**
- **OEM Pricing Available**

TYPICAL APPLICATIONS

General Scope Documentation
PC Screen Documentation
Medical Imaging, Ultrasound

A camera can be a key part of your measurement system. It allows you to capture events, document the results, and it helps to *communicate* the results with clarity and credibility.

The C-4 is a high-quality CRT-documentation camera at an affordable price. The C-4 is an easy-to-use handheld camera system that uses Polaroid instant pack films that develop in seconds, giving you immediate results. The C-4 is ideal for the lab, classroom, medical facility, TV studio, or design bench. Three video hoods allow instant prints to be made from many common video CRTs.

A Snap to Use

Anyone can take sharp, quality instant pictures after just a few minutes of familiarization with the camera and manual. No photographic skill or training is required!

Portable

The C-4 is hand-held, thus easily moved between test locations without having to remove mounting hardware.

For easy handling, the contoured pistol grip includes a trigger button for the shutter release.

Tektronix and Non-Tektronix Product Compatibility

The five easily interchangeable hoods allow the C-4 camera to fit most Tektronix and non-Tektronix oscilloscopes and CRT displays.

The C-4 is recommended for scopes with illuminated graticules or bistable storage displays. On nonilluminated graticule scopes, the C-4 will only record the waveform. The Tektronix C-5C Camera, with flash, is recommended for scopes that do not have an illuminated graticule.

For Tektronix products compatibility, see pages 484 and 485. For other Tektronix products not listed, and non-Tektronix oscilloscopes and CRT-based products, refer to mechanical and field of view compatibility below.

Hood Selection

The hood is a key part of the C-4 system since it places the camera at the correct distance from the CRT screen, blocks out ambient light, and has a built-in corrector lens to properly focus the image and set the magnification ratio. Each hood has two snap locks to ensure quick interchangeability.

Mechanical Compatibility

It is suggested that the hood's front lip dimensions be used as a guide when determining physical compatibility (see Adapter Hood Selection Guide on next page). Note: Hoods can fit around the CRT bezel or they can fit against the CRT's face, inside the bezel.

Field of View Compatibility

Check to see that the hood selected provides a large enough field of view (how large a CRT display the camera will fully record). Refer to Scope Hood Selection Guide on the next page.

CHARACTERISTICS

Aperture—f/32 to f/4.5 (continuously variable).
Lens—Four glass elements.
Focal Length—105 mm nominal (without hood).
Magnification—Dependent on hood. See Adapter Hood Selection Guide.
Resolving Power—At Center: At least 6 lines/mm. At Camera: At least 3 lines/mm.
Relative Light Gathering Ability—See Adapter Hood Selection Guide.
Field of View—Dependent on hood. See Adapter Hood Selection Guide.
Shutter—Mechanical; $^1/_{125}$ s to 1 s, and bulb.
Synchronization—X-sync switch closure occurs when the shutter reaches its fully open position.

C-4 VIDEO PRODUCT COMPATIBILITY GUIDE

The following lists compatibility currently tested. Please refer to pages 484 and 485 for determining compatibility with products not listed.

Display	C-4 Video Hood	
	Opt 11	Opt 12
Option 10 hood fits the 11401 and 11402 equivalent time scopes		
Tektronix: 4104(A), 4105(A), 4106(A), 4107(A)		✓
Ann Arbor Ambassador*1*4		✓
Apple II Monitor G0905	✓	
Apple MacIntosh Display	✓	
Compaq "Plus"*2	✓	
DEC VR-241*1		✓
DEC MATE II VR-201A*2*3*4		✓
Heathkit H-19*2		✓
IBM PC Jr. Monitor 4863*1		✓
IBM Color PC Monitor 5153		✓
IBM PC Portable	✓	
NEC JB-1201M Monitor		✓
Panasonic TR-930 Monitor	✓	
Quad Chrome Color Monitor		✓
Sony KV1217 Color Monitor		✓
Tandy Color Monitor 16-230	✓	
Zenith ZVM-122*2	✓	
Zenith ZVM-121*2*4		✓
Zenith ZVM-135		✓

*1 *Cuts off some of the CRT.*
*2 *Tends to have soft focus.*
*3 *Possible light leaks since CRT has less curvature than the hood.*
*4 *Optical distortion more noticeable.*

Note: Will not work on:
- *Tek: 4025, 4027, or 4050 Series.*
- *Tandy Computers with built-in CRTs.*
- *Apple IIc Monitor A2M2010.*

For additional hoods, see next page.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	180	7.4
Height		
With pistol grip	236	9.3
Without pistol grip	119	4.7
Depth		
With standard hood	363	14.3
Without standard hood	185	7.3
Weight ≈	**kg**	**lb**
Net		
With standard hood	1.0	2.1
Without standard hood	0.8	1.8

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

ORDERING INFORMATION

Additional hoods must be purchased separately. See Adapter Hood Selection Guide.

C-4 Camera **$375**

Includes: Body; Pistol Grip (122-0901-00); hood (122-0894-01); operator manual (070-5000-00).

OPTIONS

Option 01—Delete Hood (Body only). **– $45**

Option 02—Substitute 122-0895-01 Hood. **NC**

Option 03—Substitute 122-0896-01 Hood. **NC**

Option 10—Substitute 122-0897-01 Hood. **+ $34**

Option 11—Substitute 122-0898-01 Hood. **+ $34**

Option 12—Substitute 122-0899-01 Hood. **+ $53**

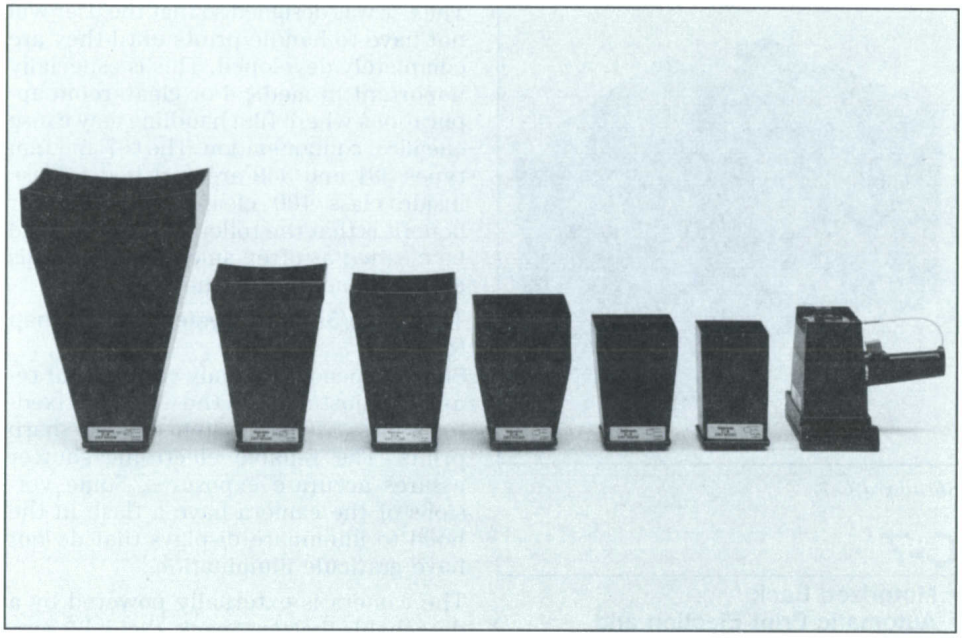
OPTIONAL ACCESSORIES

Split-Image Focus Plate—Fits into the pack film back (with no film loaded, useful to determine if image is properly in focus and entirely within the camera's field-of-view).
Order 387-0893-02 **$5.50**

Color Filter Kit—Consists of 40.5-mm screw-in 85B filter, corrects the color film balance for most color CRTs.
Order 122-0909-00 **$13.50**

For ordering films, see page 482.

Special pricing terms and conditions are available to qualified OEMs. Contact your local Tektronix Sales Engineer for complete information.



C-4 Camera Body with hoods: (Left to Right) Option 12, Option 11, Option 10, Option 02, standard, and Option 03.

ADAPTER HOOD SELECTION GUIDE

Extend the C-4's flexibility with additional snap-on hoods

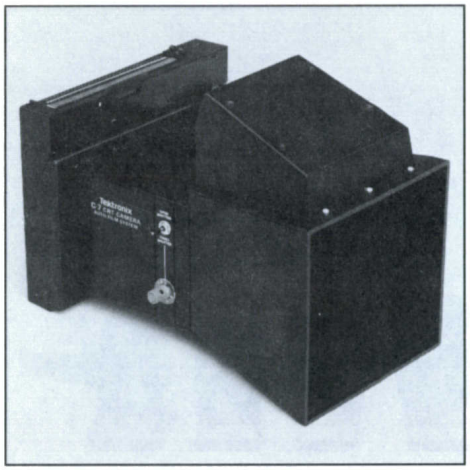
SCOPE HOODS

Scope Hood Part Number	Dimensions*1 Nominal Front Lip Height*3 mm	Height*3 in.	Width*3 mm	Width*3 in.	Hood Length*2*5 mm	Hood Length*2*5 in.	Relative Light Gathering	Field of View*1 (cm)	Magnification	Hood Net Weight kg	Hood Net Weight lb	Hood Price Only
122-0894-01 with Std C-4	108	4.2	122	4.8	178	7.2	0.15	9.1×11.87	0.8	0.1	0.3	$45
122-0895-01 with Option 02	132	5.2	143	5.6	206	8.1	0.18	10.4×13.5	0.7	0.2	0.4	$60
122-0896-01 with Option 03	80	3.2	100	3.9	171	6.8	0.14	8.0×10.0*2	0.85	0.1	0.3	$55

VIDEO HOODS

Video Hood Part Number	Dimensions*1 Nominal Front Lip Height mm	Height in.	Width mm	Width in.	Diagonal Inside mm	Inside in.	Outside mm	Outside in.	Hood Length*5 mm	Hood Length*5 in.	Magnification	Hood Net Weight kg	Hood Net Weight lb	Hood Price Only
122-0897-01 with Option 10	114*3	4.5*3	159*3	6.3*3	183	7.2	188	7.4	244	9.6	0.55	0.3	0.7	$79
122-0898-01 with Option 11	127*3	5.0*3	168*3	6.6*3	211	8.3	213	8.4	257	10.1	0.55	0.3	0.7	$80
122-0899-01 with Option 12	186*4	7.3*4	262*4	10.3*4	318	12.5	323	12.7	404	15.9	0.35	0.6	1.4	$100

*1 *Nominal dimensions.*
*2 *Image size is limited by front opening of the hood.*
*3 *For outside dimensions add 0.30 cm (0.12 in.) to each value. Each wall thickness nominally is 0.15 cm (0.06 in.).*
*4 *For outside dimensions add 0.14 in. to each value. Each wall thickness nominally is 0.07 in.*
*5 *From mounting surface to front lip.*



Standard C-7.

C-7

- **Motorized Back**
- **Automatic Print Ejection and Development**
- **Uses Integral AutoFilm From Polaroid**
- **No Focusing Required**
- **Reliable, Electronically Activated Remote or Manual Shutter**
- **Audible Indicators**
- **Protective Circuitry**
- **Battery or AC Power Supply Operation**
- **Snap-On Print Holder**
- **Graticule Flash on Some Versions**
- **OEM Pricing Available**

TYPICAL APPLICATIONS

General Scope Documentation
Medical Imaging, Ultrasound
SEM, Clean Room Applications

The Tek C-7 Auto-Eject Camera Delivers Hands-Off Hard Copies in Seconds

This general-purpose CRT camera incorporates Polaroid's AutoFilm system that includes a motorized camera back, three integral films, and a snap-on holding chamber.

The camera automatically ejects the film after each exposure. Once ejected, the film develops in about 60 seconds to a clean, dry print or transparency. No trimming, peeling, or coating is necessary. Prints or transparencies can be collected in the snap-on holder (which is required for the first 30 seconds of transparency film development).

The C-7 was designed so that the user will not have to handle prints until they are completely developed. This is especially important in medical or clean-room applications where film handling may cause chemical contamination. The C-7 and film types 331 and 339 are certified for use inside class 100 cleanrooms. Another benefit is that the rollers will not have to be cleaned as often since the chemicals are contained inside the print.

The Lens/Shutter System is a Snap to Use

Shutter speed is the only control that requires adjustment on the C-7. The fixed-focus glass f/16 lens system delivers sharp prints. The reliable electronic shutter assures accurate exposures. Some versions of the camera have a flash in the hood to illuminate displays that do not have graticule illumination.

The camera is externally powered by a detachable battery pack (held by two velcro strips), an ac power supply, or your own power source.

An Advanced Feature Set Brings a New Standard of Convenience to Photographic Recording

The C-7 has audible indicators that beep after last exposure, and after each exposure when the input voltage is low.

The camera can be operated by the manual shutter or by an optional foot switch via the remote shutter input jack.

Protective features include: voltage regulation, overcurrent foldback protection, and under-voltage warning (buzzer).

Magnification can be changed by reversing the lens/shutter module and the spacer modules positions.

Mounting and dismounting is easily accomplished on instruments with Tek-style bezels.

You'll find the built-in CRT viewing door handy when setting up for a picture.

There is even a built-in exposure counter in the camera back!

Polaroid AutoFilm

The Tektronix C-7 Camera System uses Polaroid's AutoFilm exclusively. These integral films were especially developed to work in Polaroid's motorized AutoFilm back which the C-7 uses:

- Type 331 (ASA 400) is a black-and-white extended gray-scale film for video-image recording, providing prints that reproduce the full range of black-and-white densities displayed on video monitors and scope CRTs.

  Presently, there is no high-speed film available for the C-7, therefore applications using the C-7 may be limited. (Faster film(s) may become available from Polaroid at a later date.)
- Type 336 (ASA 100) is a black-and-white high-resolution negative transparency film. Scheduled for availability from Polaroid.
- Type 339 (ASA 640) is a high-speed color-print film for reproducing color CRT displays. (The color film provides a print with a reversed or mirror image unless the CRT-screen image is electronically reversed before making the exposure. This is a function of the film design, not the C-7.)

The AutoFilm's usable image area is 4×3 in., though the actual image size will depend on the magnification and the size of the display. The AutoFilm film packs do not contain internal batteries.

The 10-exposure film packs mean fewer film changes for you. When the C-7 ejects the last print, the camera will automatically produce an audible tone for about 1 second.

Product Compatibility

The C-7 camera can be mounted on most models of Tektronix oscilloscopes and small monitors, using the same hoods as the C-5C. See page 484 for compatibility chart.

Non-Tek displays can be photographed if the product uses a Tek-style bezel, or if the camera is held up to the CRT.

Your local Tek Sales Engineer has selected listings of non-Tek products that are compatible with the C-7. The best test is to actually try one on your display.

Technical assistance with AutoFilm is available from Polaroid. In U.S. call 1-800-343-5000. Outside U.S. contact local Polaroid dealer.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center,
Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

Shown above: C-7 and options. Rear left to right: Standard C-7, with Option 01, with Option 02, with Option 03, with Option 04, with Option 05, with Option 20, OEM camera with view ports. Front left to right: Print holding chamber, foot switch, battery pack, service manual, 110 V ac power supply.

CHARACTERISTICS

OPTIONAL/MECHANICAL

Relative Aperture—Fixed at f/16.
Magnification Factor—0.67 or 0.85.
Lens—Three glass elements.
Relative Light-Gathering Ability—0.02.
Field of View (Nominal)—8.1×10.7 cm (13.4-cm diagonal) at 0.85 mag; or 10.3×13.8-cm (17.3-cm diagonal) at 0.67 mag.
Shutter—Electronic Actuated: 1/10 to 5 s, open-shutter mode.
Remote Shutter Jack—Open collector TTL compatible (for use with foot switch).
Time Between Shots—≈4 s (plus shutter time).
Audible Indicators (Buzzer)—Out-of-Film Warning: After tenth print is ejected, buzzer will sound for approximately one second. Low- or High-Voltage Warning: Buzzer will sound during the film-eject cycle when the batteries start to get weak.
Status Outputs—Various status outputs (switch closures and openings) such as "end of film," "dark slide," etc., are available only as a modified product.

POWER REQUIREMENTS

The C-7 requires external power from an ac power supply, battery pack, or a customer supplied source via a Lemo connector.
Voltage—8 V to 12 V. (Can be configured for 5 V to 12 V, see service manual.)
Current—Idle: ≈1 mA. Maximum: 3 A for 10 s.
Mechanical Interface—Lemo type connector (cable end connector, Tektronix part number 131-0778-00).

POWER SUPPLIES (OPTIONAL)

110 V (119-1847-02)—Output Voltage: 9.5 V nominal. Output Current: 1.5 A nominal, 3 A peak. Line Voltage: 90 to 132 V ac, 50 to 60 Hz nominal.

Battery Pack (016-0799-01)—Number of Cells: Eight. Type of Cells: Alkaline or NiCad AA. (Batteries not included, velcro strips included.)

PHYSICAL CHARACTERISTICS

Std C-7 w/Flash Dimensions ≈	mm	in.
Width	180	7.1
Height to top of flash	196	7.7
Height with chamber	264	10.4
Depth	251	9.9
Weight ≈	**kg**	**lb**
Net	1.3	3.7
Shipping	2.6	5.8

Hoods—Uses C-5C adapter hoods. Refer to hood's dimensions on page 487.

ORDERING INFORMATION

C-7 requires a power source (does not come as a standard accessory). Order Opt 30*1, Opt 31*1, or use your own power via Lemo connector.

C-7 Camera with Flash — **$595**
Includes: Adapter hood (016-0357-01); print holding chamber (122-1039-00); circuit board covers for 0.67 mag (200-3074-00); for 0.85 mag (200 3031-00); operator manual (070-5127-00).

OPTIONS

Option 01—016-0357-01 Hood and no Flash. — **– $30**
Option 02—016-0359-01 Hood and Flash. — **NC**
Option 03—016-0359-01 Hood and no Flash. — **– $30**
Option 04—016-0358-01 Hood and Flash. — **NC**
Option 05—016-0358-01 Hood and no Flash. — **– $30**
Option 20—Camera Body Only, no Flash or Hood. — **– $40**
Option 30*1—With 016-0799-01 Battery Pack (batteries not included). — **+ $30**
Option 31*1—With ac Power Supply (110 V). — **+ $55**

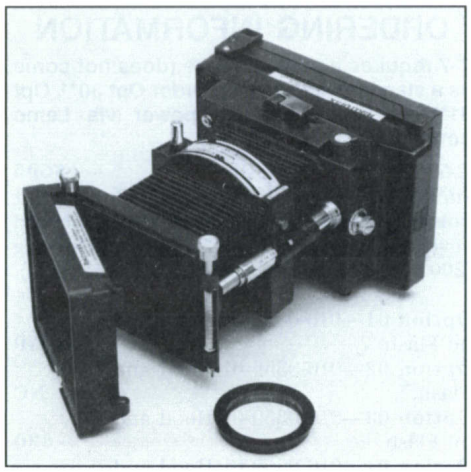
*1 *One of each power source can be ordered.*

OPTIONAL ACCESSORIES

Polaroid AutoFilm—Type 331—B&W print, with extended gray scale (400 ASA) 3 twin packs (60 prints). Order 006-6815-00 — **$58**
10 twin packs (200 prints). Order 006-6816-00 — **$190**
Type 339—Color print (640 ASA) 3 twin packs (60 prints). Order 006-6813-00 — **$71**
10 twin packs (200 prints). Order 006-6814-00 — **$220**
Extra Print Holding Chamber—Order 122-1039-00 — **$22**
Foot Switch With 8-ft Cable—Order 260-1189-02 — **$22.50**
Extra Battery Pack With Lemo Connector—Batteries not included. Order 016-0799-01 — **$30**
Lemo Connector for Power-In—Order 131-0778-00 — **$17**
AC Power Supply—8-ft cable with Lemo Connector, 110 V ac Version. Order 119-1847-02 — **$70**
Service Manual—C-7 Camera. Order 070-5051-00 — **$10**

For additional hoods, graticule flash unit, or large viewing door, see C-5C Optional Accessories section on page 487.

Special pricing terms and conditions are available to qualified OEMs. Contact your local Tektronix Sales Engineer for complete information.



C-30 Option 01 (With Corrector Lens Off)

C-30 Series

- **Adaptable to Many Instruments**
- **Standard Models Cover 0.8 cm/div CRTs**
- **Optimized for 8×10-cm CRTs (Option 01)**
- **Continuously Variable Magnification (C-30B)**
- **Writing Speed Enhancer Available**
- **Fast Light-Gathering Ability, With C-31B (0.5 Mag)**
- **Interchangeable Backs**
- **Swings Away for CRT Viewing**
- **OEM Pricing on C-30B**

The standard versions of the C-30B and C-31B are primarily for use on the older 400-Series portables that have 0.8 cm/div CRTs. (Mounting adapter, 016-0306-01, is included.)

The Option 01 models are the same cameras except that a slip-on corrector lens is used for coverage of 8×10-cm displays, and a different mounting adapter (016-0269-03 for 2400 Series, 465, etc.) is included.

The C-30B/C-31B cameras can be used on some 7000- and 5000-Series lab scopes (with 8×10-cm displays); 300 Series; Sony/Tek portables; as well as some 600 Series monitors. See Camera Selection Guide on pages 484 and 485 for compatibility information.

Dual swing-away hinges allow the camera to be swung out of the way, either to the left or right, for direct viewing of the CRT. The cameras are focused using a split-image focus plate placed inside the Polaroid back. Graflok back cameras use the back's (Graflok) built-in viewing glass.

C-30B

The C-30B is a versatile, general purpose camera for scopes that have 0.8-cm/div CRTs. The C-30B offers a highly reliable mechanical shutter and an f/1.9 lens. It is the only Tektronix oscilloscope camera that features continuously variable magnification (from 0.7 to 1.5) giving you greater photographing flexibility. This version is recommended for the 453, 454, 485 and 491.

C-30B Option 01

The C-30B Option 01 offers an expanded field of view. The f/1.9, 0.8 magnification lens covers an 8×10-cm CRT screen without vignetting. This camera is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

The C-30B with corrector lens is optimized for use at 0.8 mag only.

CHARACTERISTICS (C-30B)

Specifications are the same for the C-30B and C-30B Option 01 unless otherwise noted.
Aperture—Variable from f/1.9 to f/16.
Lens Speed—f/1.9.
Magnification—Variable from 0.7 to 1.5 (0.8 magnification on Option 01 with C-30B set to 1.0 magnification).
Resolving Power—(at 1:1 magnification). At Center: At least 25 lines/mm. At Corners: At least 10 lines/mm.
Relative Light-Gathering Ability—1.0 (0.9 on Option 01).
Shutter—Mechanical; 1/125 to 1 s; bulb and time.
Synchronization Output—X-sync contact closure.
Field of View—Standard: 7.0×9.0-cm. Option 01: 8.0×10.0-cm.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	191	7.5
Height	130	5.1
Depth	254	10.4
Weight ≈	**kg**	**lb**
Net	2.2	4.8
Shipping	4.1	9.0

C-31B

This camera's f/1.3, 0.5-magnification lens offers the fastest writing speed for 2400- and 400-Series oscilloscopes. The 0.5 magnification means that the image size on the print will be approximately one half of the C-30Bs. The C-31B is for 0.8 cm/div CRTs (453, 485, 491, 454).

C-31B Option 01

The C-31B Option 01 offers an expanded field of view. This f/1.2, 0.43 magnification lens system has a relative light-gathering ability of 2.9 covering CRT screens up to 8×10-cm. It is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

CHARACTERISTICS (C-31B)

Specifications are the same for the C-31B and C-31B Option 01 unless otherwise noted.
Aperture—Variable from f/1.3 to f/16.
Lens Speed—f/1.3
Magnification—Fixed at 0.5 (0.43 on Option 01).
Resolving Power—At Center: At least 30 lines/mm. At Corners: At least 15 lines/mm.
Relative Light-Gathering Ability—2.7 (2.9 on Option 01).
Shutter—Mechanical; 1/125 to 1 s; bulb and time.
Synchronization—X-sync contact closure.
Field of View—Standard: 7 cm×9 cm. Option 01: 8 cm×10 cm.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	231	9.2
Height	140	5.5
Depth	269	10.6
Weight ≈	**kg**	**lb**
Net	3.1	6.8
Shipping	5.4	11.0

ORDERING INFORMATION

("P" denotes that the camera has a 3×4 in. pack film back. All models include Polaroid pack film back.)

C-30BP Camera **$1,500**
Includes: Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); mounting adapter (016-0306-01); instruction manual (070-2825-00).
Option 01—Expanded Field of View. **+$48**
Includes: Same as C-30BP except it comes with 016-0269-03 mounting adapter instead, plus corrector lens (352-0341 01).
C-31BP Camera **$1,775**
Includes: Same as C-30BP, except instruction manual 070-2869-00 instead.
Option 01—Expanded Field of View. **+$48**
Includes: Same as C-31BP except it comes with 016-0269-03 mounting adapter instead, plus corrector lens (122-0980 00).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

C30/C31

CONVERTING OPTION 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the corrector lens, removing the mounting adapter, and adding an 016-0306-01 mounting adapter. Refer to pages 484-485 for compatibility and price.

CONVERTING STANDARD MODEL TO OPTION 01 MODEL

A standard-model C-30A/B or C-31B can be converted to an Option 01 model by means of a conversion kit which contains a mounting adapter (016-0269-03) plus the appropriate corrector lens (see Option 01's "Included Accessories").

(Std C-30A/B to Option 01)
Order 016-0301-01 **$115**
(Std C-31B to Option 01)
Order 016-0269-04 **$110**

See pages 484-485 for prices and compatibility.

OPTIONAL ACCESSORIES (C-30 SERIES)

Mounting Adapters—See pages 484-485.

Writing-Speed Enhancer—(For C-30A/B and C-31B) Increases effective film speed about 3X for 3,000 speed film. Now supports 20,000 ASA (612) film. Installs in minutes. See page 481. Order 016-0284-02 **$290**

Polaroid Pack Film Back—Accepts Polaroid 3×4 in. pack film for C 30A and C-30B. Included with "P" models. (Focus plate included.) Order 122-0752-02 **$190**

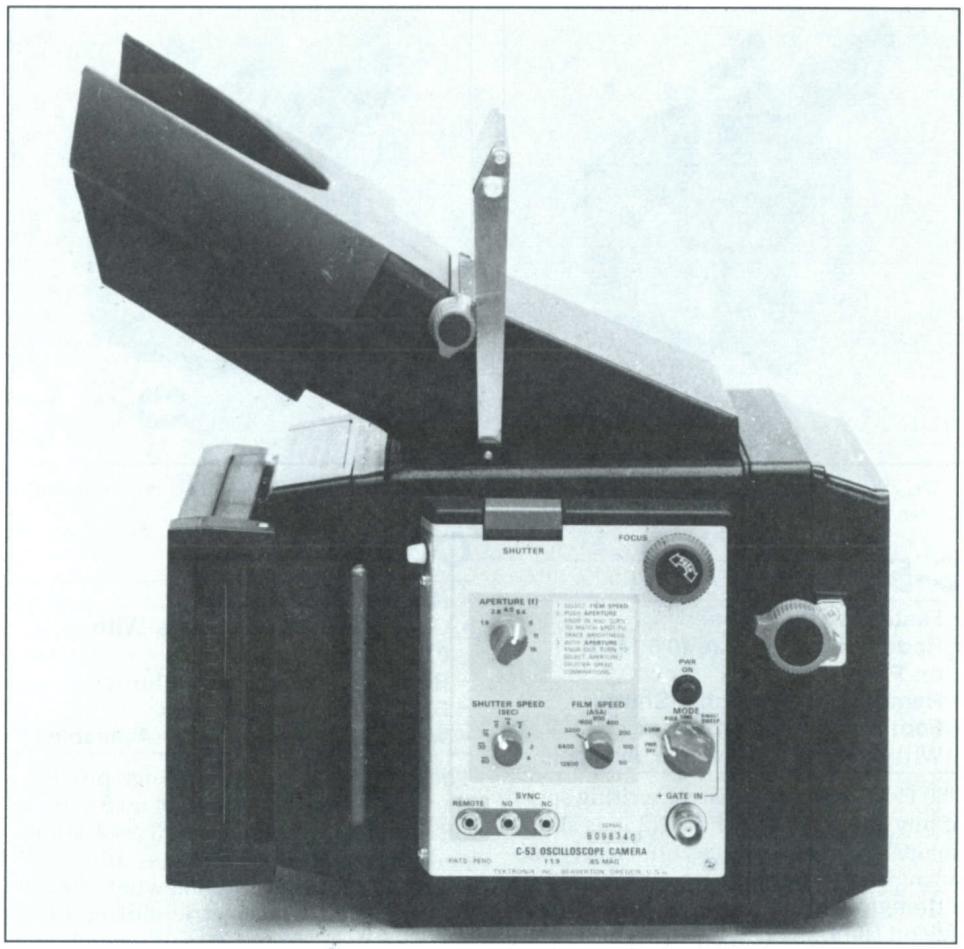
Split-Image Focus Plate—Included with "P" models. Order 387-0893-02 **$5.50**

Graflok Type 4×5 in. Back—Accepts Polaroid Land 4×5 in. film holders, standard cut-film holders, filmpack adaptors, roll-film holders (except heavy motorized roll film holders). Order 016-0487-00 **$275**
See below for film holders which are required for operation.

Carrying Case—Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5×14.5×8 in. Order 016-0587-00 **$130**

X-Sync Cable—Order 012-0364-01 **$28**

Portra Lens—A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a maximum distance of 21 in. the camera covers 19×21 in. Usable with either the C-30B or C-30B Option 01 (but not with the C-31A or C-31B). Order 016-0246-02 **$38**



C-50 Series

- **Electronic-Actuated Shutter (C-51, C-53)**
- **High-Resolution Images**
- **Photometer Exposure Aid**
- **Range-Finder Focusing**
- **Interchangeable Film Backs**
- **Swings Away From Scope**

The Top of the Line

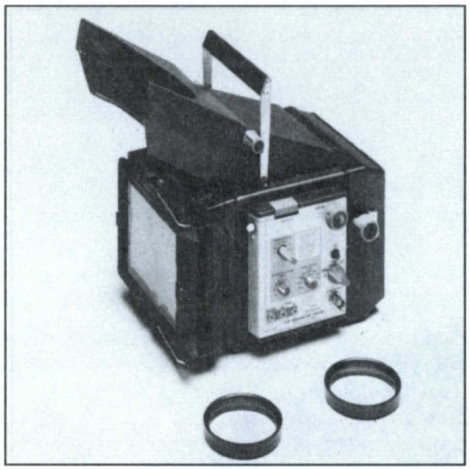
The C-50-Series cameras are designed for use with all Tektronix 7000-Series oscilloscopes, the 11301/11302, and can be adapted to fit most 5000-Series oscilloscopes and other Tek instruments. Full selection of film backs, and adjustable film and shutter speeds provide the flexibility to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces. X-sync connectors allow the camera shutter to trigger the event. The camera's built-in viewing tunnel lets you see what's on the display when the camera is in place.

The camera shutter (C-51 and C-53) is electrically actuated, open and close, by shutter button or remotely through a remote-input connector located on the side control panel.

When a C-50-Series camera is used with Tektronix 7000-Series oscilloscopes, a three-pin connector in the scope bezel applies power to the camera and receives from the camera a pulse for resetting the scope sweep when the scope and camera are both in single-sweep mode. Also, when the scope and camera (C-51 and C-53 only) are in the single-sweep mode, the "+gate" output from the scope can be applied to the "+gate" input connector on the camera to close the shutter five seconds after the end of the scope sweep.

Special screw-on connection lenses are available to adapt the cameras to the new 11301/2 scopes. See page 495 for choosing the correct options.

The C-51 and the C-53 are available in rugedized versions. Contact your Tektronix Sales Office for further details.



C-51G (Shown with Option 11 and 12 corrector lens off)

C-51

- **Fastest Writing Speed**
- **Reduced Image Size (0.5 Mag) on Print**
- **Remotely Controllable Shutter**
- **Foot Switch Available**
- **Writing Speed Enhancer Available**

The C-51 offers the fastest writing speed of any Tek camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to the image size on the film. The electric shutter can operate at speeds ranging from 1/60 to 4 seconds and offers bulb, time, and single-sweep modes by manual or remote control. Two screw-on connector lenses for 11301/11302 compatibility are available.

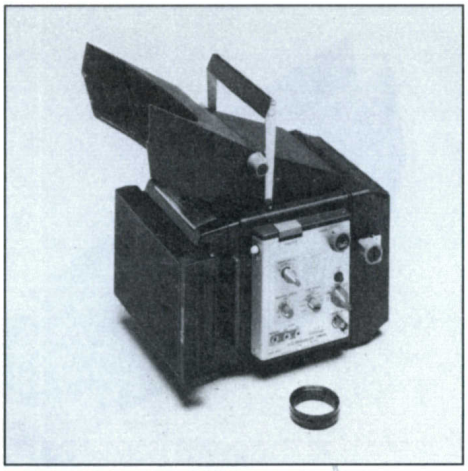
CHARACTERISTICS

Aperture—Variable from f/1.2 to f/16.
Magnification—0.5
Resolving Power—Center: At least 30 lines/mm. Corners: At least 15/mm.
Relative Light-Gathering Ability—3.0
Shutter—Electric; 1/60 to 4 s, bulb, time, and single-sweep modes, manual or remote control. Scope's "+gate" is used for shutter actuation.
Synchronization—X-sync switch closure.
Power Requirement—+15 V from 7000-Series oscilloscopes, or an optional battery pack for non-7000-Series instruments (see next page).
Field of View—8×10 cm (with pack film).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	248	9.8
Height	292	11.5
Depth	273	10.8
Weight ≈	**kg**	**lb**
Net	4.3	9.5
Shipping	6.8	15.0

For Ordering Information see next page.



C-53P (Shown with Option 11 corrector lens off)

C-53

- **Medium Speed**
- **General-Purpose Camera With 0.85 Mag**
- **Remotely Controllable Shutter**
- **Foot Switch Available**
- **Writing Speed Enhancer Available**

The C-53, with 0.85 mag lens, provides the largest practical image of an 8×10-cm CRT display on Polaroid 3¼×4¼-inch pack film. Its f/1.9 lens and 0.85 magnification offer somewhat slower writing speed. The electric shutter offers speeds ranging from 1/60 to 4 seconds and can be operated manually or remotely in bulb, time, or single-sweep modes. A screw-on connector lens is available for the 11302 compatibility.

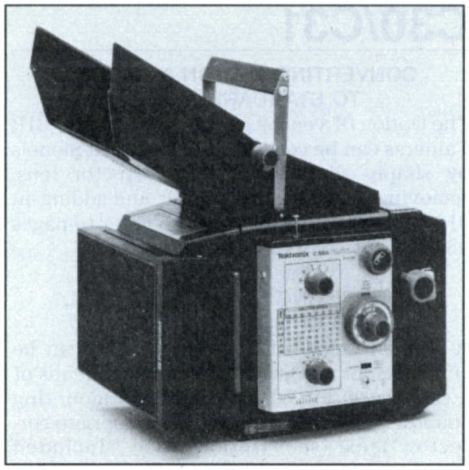
CHARACTERISTICS

Aperture—Variable from f/1.9 to f/16.
Magnification—0.85
Resolving Power—Center: at least 30 lines/mm. Corners: at least 15 lines/mm.
Relative Light-Gathering Ability—1.0.
Shutter—Electric; 1/60 to 4 s, bulb, time, and single-sweep modes, manual or remote control. Scope's "+gate" is used for shutter actuation.
Power Requirement—+15 V from 7000-Series oscilloscopes, or an optional battery pack for non-7000-Series instruments (see next page).
Synchronization Output Jack—X-sync switch-closure output.
Field of View—8×10-cm (with pack film).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	191	7.5
Height	292	11.5
Depth	273	10.8
Weight ≈	**kg**	**lb**
Net	2.4	7.5
Shipping	5.4	12.0

For Ordering Information, see next page.



C-59AP

C-59A

- **For Larger CRTs (0.67 Mag)**
- **Mechanical Shutter**
- **Lowest Priced C-50 Series**
- **Photometer Exposure Aid**
- **Range-Finder Focusing**
- **Internal Battery or External Power**
- **OEM Pricing Available**

The C-59A is designed for CRTs up to 6½ inches (10.2×12.7-cm field of view with Polaroid pack film). With the 016-0288-01 kit, the field of view is expanded to fully cover the display and adjacent scale readout characters of the Tek 576 Curve Tracer and 5030-Series scopes. Many of the features of the higher priced C-50-Series are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb/time operating modes, x-sync contacts, and film-back interchangeability.

CHARACTERISTICS

Aperture—Variable from f/2.8 to 1/16.
Magnification—0.67.
Resolving Power—Center: At least 10 lines/mm. Corners: At least 4 lines/mm.
Relative Light-Gathering Ability—0.65.
Shutter—Mechanical; 1/125 to 1 s; bulb/time.
Power Requirement—Receives power (+15 V) from a 7000-Series scope, or an internal battery pack, 8 AA size alkalines, (12 V) if used on a non-7000-Series scope.
Synchronization—X-sync switch closure.
Field of View—10.2×12.7 cm (wider with 016-0288-01 adapter frame/corrector lens).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	193	7.7
Height	292	11.5
Depth	273	10.8
Weight ≈	**kg**	**lb**
Net	3.2	7.0
Shipping	5.0	11.0

For Ordering Information, see next page.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center,
Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

C50 Series

ORDERING INFORMATION

"P" Models accept only Polaroid pack film. "G" Models have a Graflok-type back that requires a film holder. C-59 does not include 8 AA size alkaline batteries.

Note: Power requirement is +15 V from 7000 Series Oscilloscope or from optional battery pack.

C-51G Camera **$2,410**
Includes: Mounting adapter for all 7000, 5000, and small 600 Series (016-0249-06); camera visor (337-0411-02); Graflok film back (122-0931-01) with integral focusing screen; instruction manual (070-1011-03).

C-51P Camera **$2,410**
Includes: Same as C-51G except it has a Polaroid pack film back (122-0926-02) instead of Graflok film back, and a focus plate (387-0893-02).
Option 11*1*2 Corrector lens for 11301
Option 12*1*2 Corrector lens for 11302

C-53P Camera **$1,990**
Includes: Same as C-51P.
Option 11*2 Corrector lens for 11302

C-59AG Camera **$1,375**
Includes: Same as C-51G except instruction manual (070-3632-00).
Option 11*2 Corrector lens for 11301

C-59AP Camera **$1,375**
Includes: Same as C-51P, except instruction manual (070-3632-00)
Option 11*2 Corrector lens for 11301

C-59A Kit for 576 and 5030 Series—Expands the field of view to fully cover the 6½-inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030-Series oscilloscopes. The slip-on corrector lens (352-0293-00) reduces the effective magnification of the C-59 from 0.67 to 0.5 so it can record the entire display on Polaroid 3½×4½-in. film (for the C-59A camera only). Adapts camera to 576, 5030, and 5031.
Order 016-0288-01 **$195**

*1 *One or both options can be ordered.*
*2 *Contact your local Sales Office.*

C-50 SERIES OPTIONAL ACCESSORIES

11301/11302 Connector Lenses—These lenses easily screw in or snap on the camera lens. No additional tools required.
(C-51/11301) Order 122-1043-00*2
(C-51/11302) Order 122-1044-00*2
(C-53/11302) Order 122-1045-00*2
(C-59A/11301) Order 122-1046-00*2
Mounting Adapters—See pages 484-485.
Battery Pack—Provides auxiliary +15-V power source for using the C-51, C-53 Cameras with oscilloscopes without camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000-Series oscilloscope or an external +15-V source. Includes three-pin female connectors for external power in (131-0716-00). Net weight, including batteries, is 1.2 lb. Requires eight AA size alkaline batteries (not included). Order 016-0270-02. **$340**
Writing Speed Enhancer—Provides controlled film fogging to increase writing speed by 3× for 3,000 ASA film and ≥3.5× with 20,000 ASA film. Installs in minutes. See page 481 for more information.
(C-51) Order 016-0279-02 **$270**
(C-53) Order 016-0300-02 **$290**
(C-59A) Order 016-0290-02 **$300**
X-Sync Connnector Plug—Not shown. Order 134-0079-00 **$1.30**
Foot Switch—For Remote Shutter Actuation of the C-51, C-53, with 8-ft. cable. Order 260-1189-02 **$22.50**
Carrying Case—Holds a complete C-50 Series camera with extra film backs and accessories.
Order 016-0177-00 **$285**
Polaroid Pack Film Back—Included with "P" models. Order 122-0926-02 **$185**
Focus Plate—Included with "P" models. Order 387-0893-02 **$5.50**
Graflok Type Film Back—Included with "G" models (requires a film holder, see this page), accepts Polaroid 4×5-in. film holders, standard cut-film holders, film-pack adapters, roll-film holders*1 (except heavy motorized models). Includes integral focusing screen.
Order 122-0931-00*2 **$265**

*1 *Other film holders and adapters (4×5-cm cut-film, back film, or roll film) are available at local camera stores.*
*2 *Contact your local Sales Office.*

OPTIONAL FILM HOLDERS FOR GRAFLOK TYPE BACKS (C-50 Series "G" Models or C-30 Series with Graflok Back)

Cameras with Graflok type backs must have a film holder in order to be functional.

Here are several holders*1 that allow the use of roll film, or 4×5-in. Polaroid films. Order these holders from Tek, the manufacturer, or from your local camera store.
Polaroid Land #545 4×5 in. Film Holder—For Polaroid 4×5 in. Single Exposure Film Packets.
Order 016-0201-01 **$285**
RH/10 120 Roll-Film Holder—Ten exposures 2½×2¾-in. for 4×5-in. Graflok backs.
Order 122-0736-01 **$375**

Roll film holders are also manufactured by several other companies.

*1 *Other film holders and adapters (4×5-cm cut film, pack film, or roll film) are available at local camera store.*

The following film holders are available only through Polaroid (1-800-343-5000 in the U.S.).
Polaroid #550 Film Holder—For Polaroid 4×5-in. pack films. Holder fits most 4×5 cameras and instruments equipped with Graflok backs, which accept conventional 4×5-in., film holders.
Polaroid #405 Film Holder—For Polaroid 3¼×4¼-in. pack films. Holder fits most 4×5-in. cameras or instruments equipped with Graflok backs, which accept conventional 4×5-in. film holders.

OPTICAL-TO-ELECTRICAL CONVERTERS

NEW P6701
450 to 1050 nm, DC to 700 MHz

NEW P6702
1000 to 1700 nm, DC to 500 MHz

NEW P6751
Spatial Input Head

- **Optical Oscilloscope**
- **Average and Pulse Power Meter**

The Tektronix P6701/P6702 are optical probes that allow the user to receive optical signals and convert them to electrical signals for convenient analysis on Tektronix oscilloscopes equipped with the TEKPROBE™*1 interface or any other oscilloscope when used in conjunction with a Tektronix power supply/TEKPROBE interface adapter. The conversion is linear, DC coupled, calibrated, and of high bandwidth.

Use of the TEKPROBE™ interface allows the oscilloscope to supply power to the probe, automatically determine and display the proper scale factor (in milliwatts of optical power) and set the input termination to the required 50 ohms. An oscilloscope-controlled calibrated offset of 0 to 1 mW is also available through this interface.

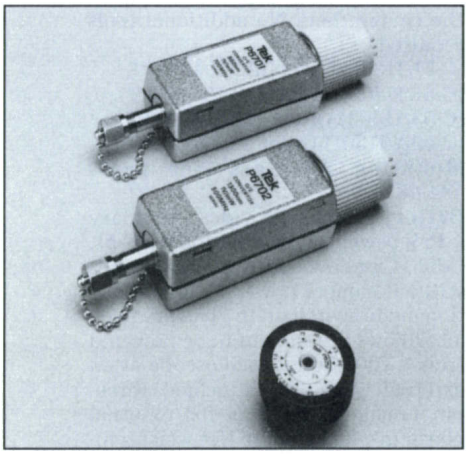
The P6701/P6702 provides a calibrated means of analog analysis of optical signals in the wavelength range 450 to 1050 nm (P6701) and 1000 to 1700 nm (P6702) thus combining the functions of an optical power meter with the high-speed analog waveform analysis capability of an oscilloscope in one instrument. The user has the capability of acquiring, displaying and analyzing mixed analog and digital, optical and electrical signals simultaneously.

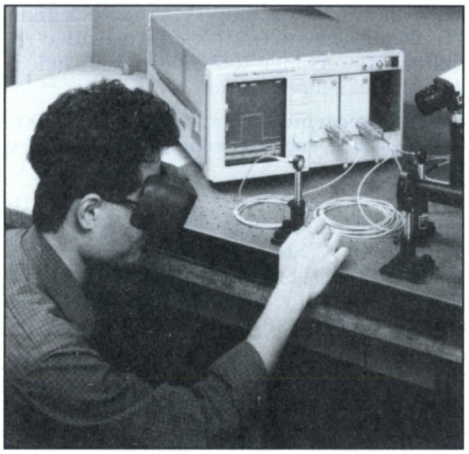
Each probe is contained in an oscilloscope probe-size compensation box and mounts directly to an 11000 series oscilloscope plug-in, thus requiring no bench space. Optical signal input is through a standard SMA or optional FC fiber optic cable connector mounted on the front of the converter.

The P6751 Spatial Input Head is a turnable lens system for sampling optical energy from any source and delivering it via a fiber optic cable to the P6701/P6702 optical to electrical converter. The P6751 is easily mounted using standard optical bench fixtures. The Spatial Input Head can be adjusted (500 to 1500 nm) by the user to optimize the amount of optical energy sampled and delivered to the P6701/P6702. The P6751 has a standard SMA fiber optic cable connector. Also available are a series of fiber optic jumper cables for interfacing the P6701, P6702, and P6751 with other industry standard optical fiber connectors.

*1 *Tektronix 11000-Series Oscilloscopes.*

TEKPROBE is a trademark of Tektronix, Inc.





TYPICAL APPLICATIONS

Applications range from measuring the transient optical properties of lasers, LEDs, electro-optic modulators, flashlamps, etc., to the development, manufacturing, and maintenance of fiber optic control networks, local area networks (LANs), optical disk devices, and high-speed fiber optic communications systems. As an example, eight P6701s/P6702s coupled with two 11A34 amplifier plug-ins and an 11000-series oscilloscope can be configured as an 8-channel optical oscilloscope!

ORDERING INFORMATION

P6701 Optical-to-electrical converter **$1,800**
Includes: Standard SMA input connector; carrying case (016-0156-03); instruction manual (070-6465-00).
Option 01—FC input connector **NC**
P6702 Optical-to-electrical converter **$1,995**
Includes: Standard SMA input connector; carrying case (016-0156-03); and instruction manual (070-6465-00).
Option 01—FC input connector. **NC**
P6751 Spatial Input Head **$295**
Includes: Adjustment tool and instruction sheet.

OPTIONAL ACCESSORIES

Optical Cables—2 meters, 100/140 micron
SMA to SMA Order 174-0879-00 **$280**
SMA to Diamond 3.5 Order 174-0877-00 **$330**
SMA to FC Order 174-0878-00 **$295**
SMA to Biconic Order 174-0880-00 **$250**
SMA to ST Order 174-0876-00 **$250**

Tektronix power supply/TEKPROBE interface adapter available the first quarter of 1988.

CHARACTERISTICS

	P6701	P6702
Wavelength response	450 to 1050 nm	1000 to 1700 nm
Bandwidth	DC to 700 MHz	DC to 500 MHz
Risetime	≤0.7 ns	≤1.0 ns
Conversion Gain	1 V/mW at 850 nm	1 V/mW at 1300 nm
Calibrated Offset	0-1 mW	0-1 mW
Max Input Optical Power	10 mW	10 mW
Power Requirements	TekPROBE™ Interface	TekPROBE™ Interface

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

CONTENTS

J16 Photometer/Radiometer 497
Illuminance Probes 499
Irradiance Probes 499
Luminance Probes 499
Uncorrected Probe 500
LED Test Probe 500
Application Notes 501

J16 Photometer/Radiometer

- **Digital LED Readout**
- **Eight Silicon Sensor Probes Quickly Interchange Without Recalibration**
- **Freedom From Saturation Effects over Entire Range**
- **Accurate Spectral and Cosine Corrections**
- **Metric and US Versions Available**
- **BCD/Analog Output (Option 07)**
- **AC or Internal Rechargeable Battery Versions**
- **Longer Battery Life—4-Hour Operation**
- **Application Notes Available**

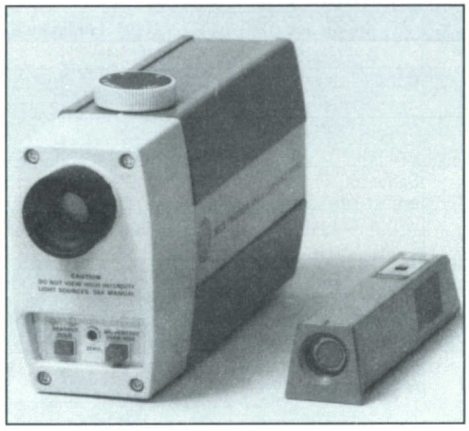
The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory, in the field, or on the production floor. A J16 System consists of a J16 mainframe and one of eight detachable probes. Probes can be either mounted on the J16 or used on the end of an extension cable. All probes have a Hold switch to allow the reading to be held.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions.

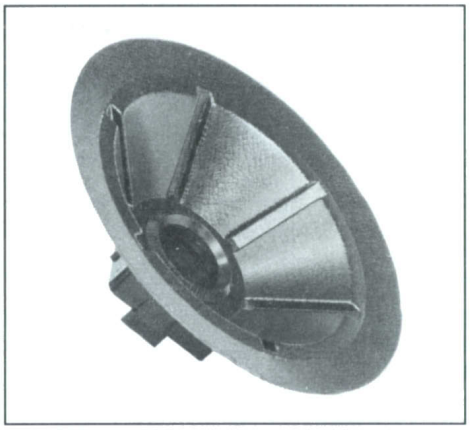
All probes use silicon photodiodes and multi-element glass filters for maximum stability and accuracy.

The optional BCD/analog output feature (Option 07) allows the user either a BCD output of the displayed reading or an analog signal (level) proportional to the light falling upon the sensor. The J16 can be also used with Tek MI 5010/50M30 system for interface with a GPIB system.

Under normal usage, the internal rechargeable nickel cadmium batteries will operate the J16 for four hours. An ac power supply is recommended for continuous operation.

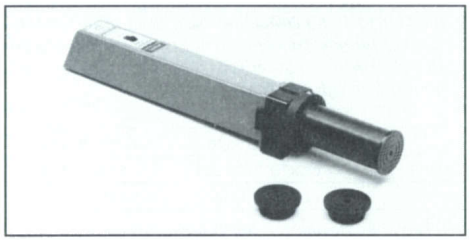


J6501 J6504 J6523
J6502 J6505
J6503



LIGHT OCCLUDER
016-0305-00

J6511 (shown)
J6512



LED ADAPTER WITH EXTRA LED HOLDER
(included with J6505)
014-0047-00

Power supplies or battery packs can be changed quickly by removing four screws on the J16's rear panel. The cabinet and probes have an internal threaded socket (¼ inch×20) for convenient mounting on a tripod or optical bench.

J16-TV Package

The J16-TV package is an excellent transfer mechanism which provides a simple, accurate method for adjustment of monitor screen color temperature. The primary colors are measured and adjusted to produce white color temperature balance.

The J16-TV with optional J6503 or J6523 measures monitor screen brightness on both color and black and white monitors. Other applications include measurement of studio lighting, camera lighting, and illumination of work areas.

The J16-TV package includes: J16 Battery-Operated Photometer, J6502 Irradiance Probe, light occluder, probe extension cable, and battery charger. See Application Note 58A-2926-1 for additional information.

GLOSSARY

Photometry—The measurement of light visible to the human eye.

Radiometry—The measurement of light within the total optical spectrum.

Color Temperature—The temperature of a blackbody whose radiation has the same visible color as that of a given nonblackbody radiator. Usually expressed in °K.

Footcandle—Unit of incident illumination.

Footlambert—A unit of illumination emitted or diffusely reflected by a source.

Units also commonly used include lux (the metric unit of illuminance) and nit (the metric unit of luminance).
1 footcandle=10.76 lux
1 footlambert=3.426 nits

Illuminance—The amount of luminous flux through a unit of surface area and is usually measured in footcandles (lumens/ft²).

Inverse Square Law—The decrease of light intensity with increasing distance. Twice the distance reduces the illumination to one-quarter.

Irradiance—The amount of radiant flux received by a unit of surface area and is usually measured in watts/cm².

Note: Other units of irradiance such as μW/cm² and W/m² are also used extensively.

Lambert's Law—Describes the spatial characteristics of a perfectly diffusing surface which may be either emitting or reflecting light. The light emitted or accepted by such a surface decreases with angle (from perpendicular) according to the cosine of the angle.

Luminance—The amount of light emitted or scattered by a surface and is usually measured in footlamberts.

Photopic—Spectral (color) sensitivity of the average human eye, predominantly peaked in the yellow-green region.

Steradian—A unit of area on the surface of a sphere equal to the radius squared. There are 12.6 steradians total area on a sphere.

Spatial—The directional characteristics of light in space.

Spectral—The distribution of light by wavelength within an electromagnetic spectrum.

Note that each radiometric unit has a photometric equivalent differing only in spectral response of the sensor. However, the units are not interchangeable.

PROBE CHARACTERISTICS

Application		Illuminance		Irradiance	Luminance		Uncorrected	Red LED
Probe		J6501	J6511	J6502/J6512	J6503	J6523	J6504	J6505
Range	US*2	0.001 to 1999 footcandles*1	0.001 to 1999 footcandles	0.001 to 1999 microwatts/cm²	0.1 to 199,900 footlamberts*1	0.1 to 19,990 footlamberts*1	Relative response only	0.001 to 1999 footcandles*1†
	Metric (Opt. 02)	0.01 to 19,990 lumens/m² (lux)*1†	0.01 to 19,990 lumens/m² (lux)*1†	0.01 to 19.990 milliwatts/m²	1 to 1,999,000 candelas/m² (Nits)*1	1 to 199,900 candelas/m² (Nits)*1	Relative response only	0.01 to 19,990 lumens/m² (lux)*1†
Accuracy (Including J16)		Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100°k tungsten halogen light source traceable to NBS		Same as J6501, except calibrated with a 762 nm filter	Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100°k tungsten halogen light source traceable to NBS		Probe-to-probe accuracy ±5% with tungsten light source	Same as J6501, except calibrated with a 656 nm filter
Spectral Response		Within 2% (integrated) of CIE photopic curve		Flat within ±7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve		UV enhanced silicon spectral curve (250 to 1200 nm)	Within 2% (integrated of CIE phototopic curve from 600 to 710 nm
Acceptance Angle		50% sensitivity at 48° off axis	Cosine corrected (180°)	50% sensitivity at 48° off axis	8°	1°	50% sensitivity at 48° off axis	
Stability and Repeatability		Within 2% per year						
Linearity		Within 2% over entire range enabling single point calibration						

*1 *An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.*

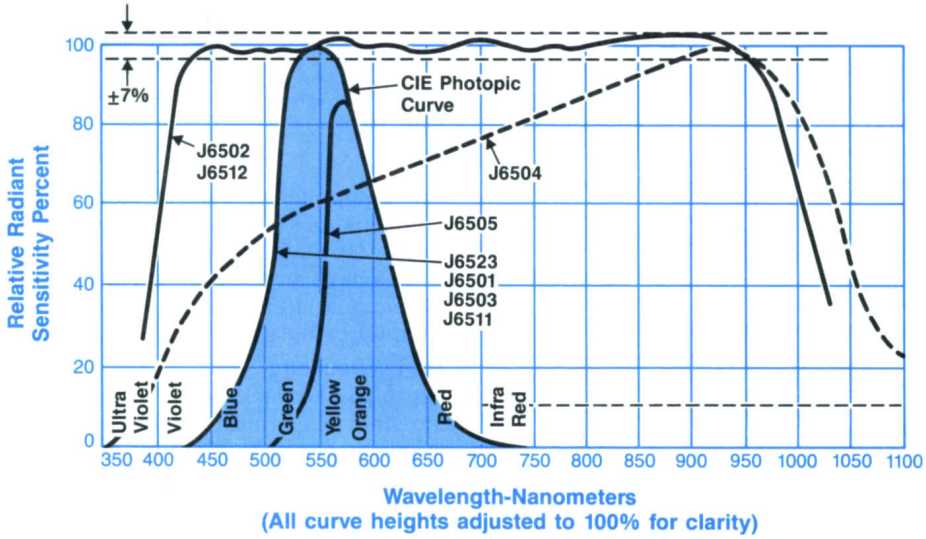
† *0.00001 to 199.9 candelas when used with 014-0047-00 LED adapter or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles × d² = candelas where d is the distance from the source to the sensor in feet. (For metric readings, use lux × d² = candelas where d is distance from the source to the sensor in meters.) Request J16 Application Notes 58A-2635 and 58A-2704-1 for further information.*

*2 US/METRIC CONVERSIONS

	US to Metric	Metric to US
Illuminance	Fc×10.764=Lux	Lux×0.0929=Fc
Luminance	FL×3.426=Nits	Nits×0.2919=FL

NOTE: C.I.E. stands for the International Commission on Illumination.

TYPICAL PROBE SPECTRAL CHARACTERISTICS

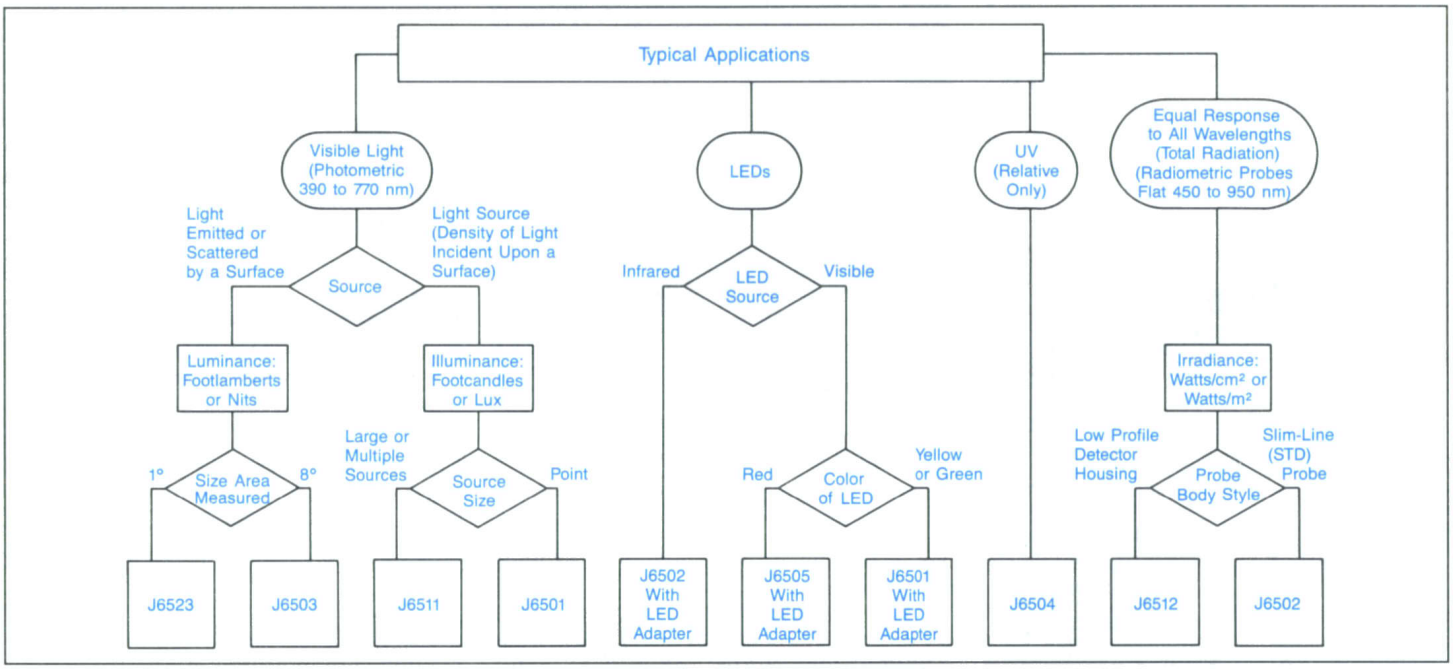


NOTE: *C.I.E. stands for the International Commission on Illumination.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

J16 PROBE SELECTION

Applications are too numerous to list, but this flowchart should help in your selection of J16 probes.*[1]



J6511/J6501

Illuminance Probes

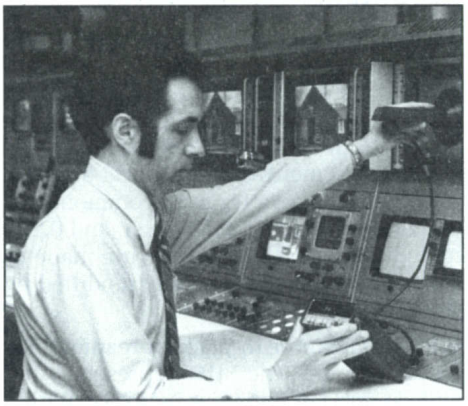
Typical Measurement Applications
- **Roadway Illumination**
- **Office Lighting**
- **Work Surface Illumination**
- **Studio Lighting**
- **Camera Setup**
- **Yellow/Green LED Testing**

The J6511 is an illuminance probe with readout in footcandles [lumens/m² (lux) for the J6511 Option 02]. A multi-element glass filter and silicon photo-diode ensure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low-light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to ensure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe (J6511) and J16 allows the user to be out of the field of view while making measurements. Where cosine correction is unnecessary, the standard J6501 probe is available with the same photopic correction and units as the J6511. The J6501 can be used to measure green and yellow LEDs.

*[1] *Refer to page 501 for available application notes.*



J16-TV System with J6502 being used for color monitor set-up.

J6502/J6512

Irradiance Probes

Typical Measurement Applications
- **Laser Research/Experimentation**
- **Radiant Efficiency**
- **Color CRT Setup**
- **Infrared LED Testing**

The J6502/J6512 measure irradiance in microwatts/cm² (milliwatts/m² with Option 02). The spectral response is flat from 450 to 950 nanometers, ±7%. The response is typically down 50% at 400 and 1030 nm.

An optional filter holder is available for the J6502 to mount standard 1 inch diameter customer-supplied filters of up to $^3/_8$ inch thickness. Where high intensity sources are used (over 1990 μwatts/cm²), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 1%, etc.). These filters may be held with an optional filter holder.

Where the 1 sq cm sensor is not completely filled by the source, for example with a laser beam, the reading obtained represents microwatts instead of μwatts/cm² or milliwatts × 10^{-4} instead of milliwatts/m² (Option 02). Small variations in sensor uniformity may add ±5% uncertainty to this measurement.

The J6512 has a low-profile detector head and six-foot cable. Longer cables available as special modifications.

J6503 8° Luminance Probe

Typical Measurement Applications
- **Video Screen Illumination**
- **Street Sign Illumination**
- **Work Surface Illumination**
- **Movie Screen Illumination**

The J6503 measures luminance in footlamberts (candelas/m² (nit) with Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface.

The probe's response is closely matched to the CIE photopic curve, ensuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8 degrees, which is determined by internal field stop apertures. Providing that the 8 degrees field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (Option 02) indicator automatically lights when the J6503 is connected.

Measuring Luminance with the Tektronix J16/J6523.

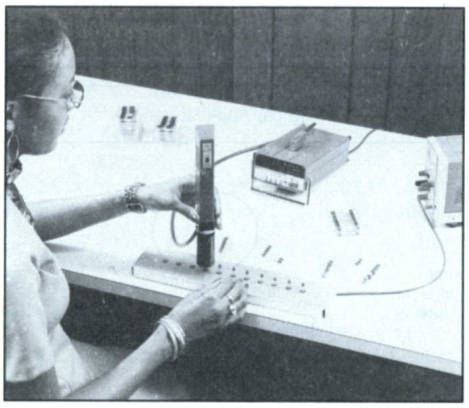
J6523 1° Luminance

Typical Measurement Applications
- **Highway Lighting**
- **Video Display Illumination**
- **Photographic Equipment Illumination**
- **Lighting Equipment Illumination**

The J6523 will measure the luminance in footlamberts (candelas/m² with Option 02) of a spot as small as 0.32 inch in diameter. By using commercially available 55-mm stackable diopters, areas as small as 0.035 inch (+10 diopters) can be measured. These 55-mm diopters are physically similar to threaded 55 mm filters, and are available from most photography stores. (See Application Note 58-AX-3252.)

The 1-degree angle represents 0.21 inch per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1-inch diameter spot.

The probe includes an optical sighting system with a 9-degree viewing field. The focusing range is 18 inches to infinity, closer with 55-mm close-up diopters. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources. The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard ¼ inch×20 threaded socket allows it to be used on a tripod or an optical bench.



J6505 Red LED Test Probe

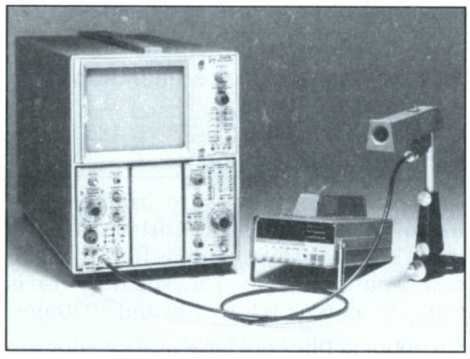
Typical Measurement Application
- **Output of Red LEDs (600-710 nm)**

Note: For yellow or green LEDs use the J6501 probe, for infrared LEDs use the J6502 probe.

The J6505 measures illuminance in footcandles (lumens/m² (lux) with Option 02), which can easily be converted into luminous intensity in candelas. (See Application Notes 58-A-2635 and 58-A-2704-1.)

An adapter supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adapter excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adapter to fit common sizes of LEDs (0.080 inch, 0.125 inch, and 0.200 inch diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adapter in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m² represents 10 millicandelas. A 10× increase in sensitivity is available on special order.



J16 used to measure pulsed light source. Refer to Application Note 58A-2702-1.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 nm to 710 nm. This close match requires compromising in the 380 to 600 nm region, making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green regions, the LED adapter must be used with the J6501, and the same conversion factor for luminous intensity applies.

J6504 Uncorrected Probe

Typical Measurement Applications
- **Photoresist/Photo-Processing Light Sources**
- **Comparison of UV Light Sources**

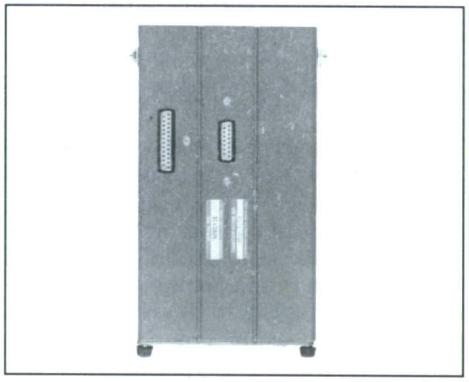
This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters.

No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

Option 07 BCD/Analog Output

The J16 is equipped with a 25-pin connector on the unit's top. This provides parallel TTL logic and BCD outputs, a "hold" input line (TTL), and a linear analog signal output 0 to −2 V or 0 to −6 V (depending upon the probe used), for a full-scale readout. The analog bandwidth is approximately 0.8 Hz. A cable-end connector and cover have been added to the accessories complement.



J16 with analog BCD output (Option 07).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

CHARACTERISTICS

J16 MAINFRAME

Display—3½ digit LED readout and three LEDs automatically indicating correct units for probe in use. Metric version readout is also available (Option 02).
Stability—≤2% per year.
Linearity—≤2% over entire range (enables single point calibration).
Integration Time—≈100 ms.
Calibration—Electrical calibration of the J16 mainframe is performed with a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

POWER REQUIREMENTS

Standard and Option 01—Has internal rechargeable NiCad batteries that require 16 hours for a full charge. The J16 will operate nominally four hours continuously on a charge. The J16 cannot be operated from the battery charger for continuous operation since the charging rate is ≈200 mA, while the J16 draws ≈400 mA. For continuous-operation an ac power supply is recommended.
Option 03 and Option 04—AC only operation, no internal batteries.

J16 AND PROBES ENVIRONMENTAL

Ambient Temperature—Nonoperating: −50 to +75°C. Operating: −15 to +40°C.
Altitude—Nonoperating: To 15 000 m (50,000 ft). Operating: To 4600 m (15,000 ft).
Humidity—Operating and Storage: Five cycles (120 hour) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.
Vibration—Operating: 15 minutes along each major axis, a total displacement of 0.025 in p-p (4 g's) from 10 to 55 to 10 Hz in one minute cycles. Held for three minutes at 55 Hz. All major resonances above 55 Hz.

PHYSICAL CHARACTERISTICS (With Probe And Battery Pack Installed)

Dimensions	mm	in.
Width	123	4.6
Height	60	2.4
Depth	203	8.0
Weight ≈	**kg**	**lb**
Net	1.5	3.3
Domestic Shipping	2.3	5.0
Export-packed	4.5	10.0

ORDERING INFORMATION

(PROBES NOT INCLUDED UNLESS NOTED)

J16 Photometer/Radiometer Battery Version, With 115 V ac, 50 to 400 Hz **$1,280**
Includes: Battery charger (119-0375-02); shoulder strap (346-0104-00); battery pack (016-0539-01); nonmetric version instruction manual (070 1879-00); or with Option 02 metric version instruction manual (070-1880 00).
J16-TV Photometer/Radiometer Package for TV Color CRT Set-Up **$1,920**
Includes: Same as J16 plus J6502 irradiance probe, light occluder (016 0305-00), 42 inch probe extension cable (012-0414-02).

OPTIONS (J16/J16-TV)

Option 01—Battery version with 230 V ac, 50 to 400 Hz charge. **NC**
Includes: Same as J16/J16-TV except battery charger 119-0375-03 is substituted.
Option 02*1—Metric Readout. **NC**
Option 03—115 V ac only operation, 50 to 400 Hz. **NC**
Includes: AC power pack (119-0404-00); shoulder strap (346-0104-00); nonmetric version instruction manual (070-1879-00); or with Option 02, metric version instruction manual (070-1880-00).
Option 04—230 V ac only operation, 50 to 400 Hz. **NC**
Includes: Same as Option 03 except it has ac power supply 119-0404-01 substituted.
Option 07—BCD/Analog Output. **+$80**
*1 *Option 02 must also be ordered for probes.*

PROBES

Actual spectral curve is included with each probe.

J6501 Illuminance Probe **$595**
J6502 Irradiance Probe **$595**
J6503 8° Luminance Probe **$595**
J6504 Uncorrected Probe **$500**
J6505 LED Probe, Includes LED Adapter and 3 LED Holders **$595**
J6511 Illuminance Probe, Cosine Corrected (with 25-ft cable) **$595**
J6512 Irradiance Probe (with 6-ft cable) **$595**
J6523 1° Luminance Probe **$1,695**

OPTIONS (Probe)

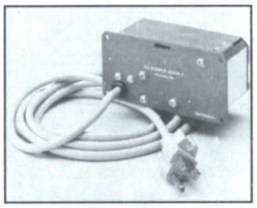
Option 02—Metric probes required for metric readout J16s (Option 02). **NC**

OPTIONAL ACCESSORIES

42-Inch Probe Extender Cable—Connects J16 to probe. Order 012-0414-02 **$110**
Probe Extender Cables Up to 30 ft are available on special order through your local Tektronix Sales Office.
Light Occluder—For TV color CRT balancing. Order 016-0305-00 **$28**
Filter Holder*1—Mounts 1 in diameter filters, of up to 3/8 in thickness, to probes (except J6511, J6512, J6523). Order 016-0527-00 **$31**
LED Adapter—With 3 LED Holders (included with J6505). Order 014-0047-00 **$90**
Tripod—Order 016-0253-00 **$135**
*1 *Filters available from vendors such as: ORIEL (203) 377-7877 or CORION CORP. (617) 429-5065 and others.*

POWER PACKS

Power packs can be quickly changed by removing four corner screws on the rear panel and sliding the power supply or battery pack out.



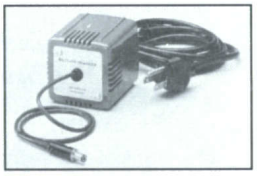
AC Power Supply

AC Power Supply—Allows J16 to be used without batteries. 115 V ac, 50 to 400 Hz (included with Option 03). Order 119-0404-00 **$245**
230 V ac, 50 to 400 Hz (included with Option 04). Order 119-0404-01 **$250**

Battery Pack

Spare Battery Pack—Order 016-0539-01 **$160**

Battery Chargers—When ordering a battery pack for your ac-powered J16, also order one of the following chargers.



Battery Charger—115 V ac, 50 to 400 Hz (included with Standard J16). Order 119-0375-02 **$135**
Battery Charger—230 V ac, 50 to 400 Hz (included with Option 01). Order 119-0375-03 **$60**

Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Sales Office or Representative regarding special application requirements.

APPLICATION NOTES

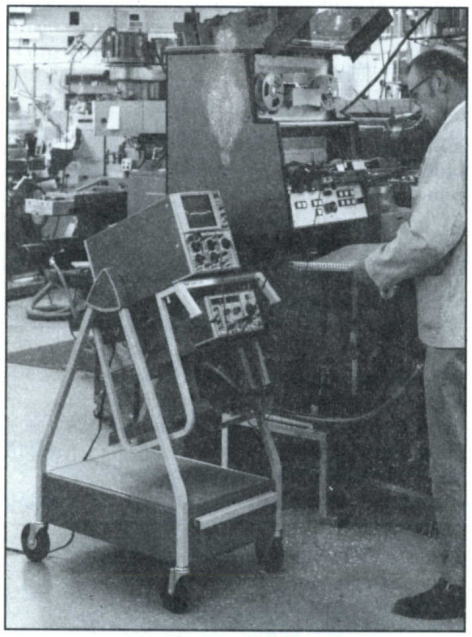
Title	Literature #
Photometry/Radiometry primer, and standardizing CRT measurements	60-W-5750
Luminous intensity and visible LED measurements w/Tektronix J16 Photometer	58-A-2635
Measuring pulsed light sources with the J16 and an oscilloscope	58-A-2702-1
Radiant intensity and infrared emitting diode measurements	58-A 2704-1
Television station applications for the J16 Photometer	58-AX-2764-1
Practical lighting measurements with the Tektronix J16	58-A-2912
TV picture monitor color temperature adjustment using the Tektronix J16	58-A-2926-1
Photographic exposure measurements with the Tektronix J16	58-AX-3060-1
Measuring the luminance of small areas of light with the J16 and J6523	58-AX-3252
Optical communications measurements	58-AX-3602

THE TEKTRONIX SCOPE-MOBILE® CART FAMILY AT WORK.

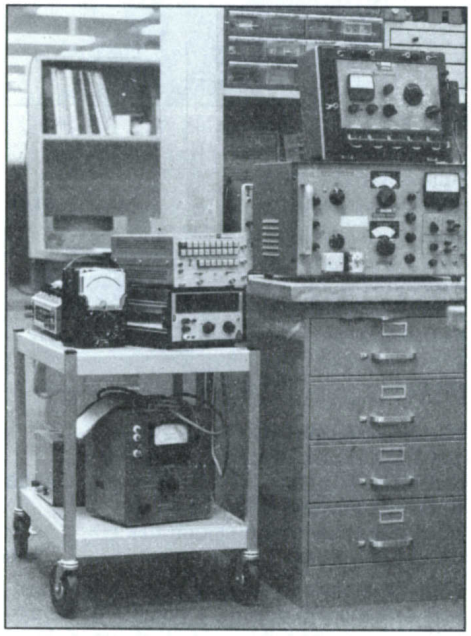
Tektronix SCOPE-MOBILE® Carts provide the quality and versatility needed by many test instrument users.

Tek carts free up your valuable table space and make sharing equipment between work benches easy while getting you closer to your device under test. They are designed for easy integration into your instrument systems. OEM pricing is available for most models.

Whatever your requirements, Tek has a cart to fit your needs.



K213



206

INSTRUMENT/CART COMPATIBILITY

	K212	K213	K213 Shelf	K217	206
Terminals/Copiers/Monitors/Plotters					
4000 Series					✓
4611/4612					✓
4631/4632					✓
4634/4635					✓
4644					✓
4660 Series					✓
4695					✓
4900					✓
4926/4970					✓
606B/608/620	x		x		
650 HR Series (Cabinet)				✓	x
670 Series				✓	x
Television/Spectrum Analyzers/Cable Testers					
1410R Series				✓	x
1420 Series	✓		x		
1430/1440				✓	x
1450/1470 Series				✓	x
1480 Series Cabinet	✓		x		x
1480 Series Rackmount				✓	x
1500 Series	✓				
1720/1730	✓		x		
1740/1750 Series	✓		x		
1910 (Cabinet)				✓	x
2710	✓				
2754/55				✓	x
380	✓		x		
490 Series	✓				
528A	✓		x		
R140 Series				✓	x
R520 Series				✓	x
OF150 Series	✓				
OF235 Series	✓				

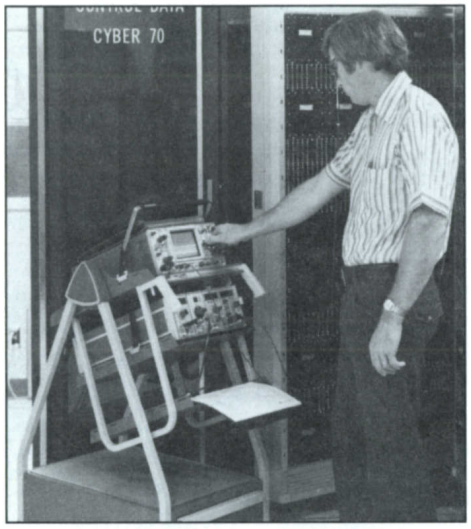
	K212	K213	K213 Shelf	K217	206
Logic Analyzers					
1240/1241	x	x	x		
308/318/338	x		x		
DAS 9100				✓	x
DAS 9200					✓
Curve Tracers					
370				✓	x
576/577		x		✓	x
Oscilloscopes/Digitizers/Controllers					
11000 Series				✓	x
2200/2300/ 2400 Series	✓	x	x		
305/314/336	x		x		
390AD				✓	x
400 Series	✓	x	x		
4041	✓		✓		
530/540/550/ 560 Series (Cabinet)		✓			x
530/540/550/ 560 Series (Rackmount)				✓	x
7000/5000 Series (Cabinet)		✓			x
7000/5000 Series (Rackmount)				✓	x
7612D/7912H				✓	x
7D20T	✓		✓		
T900 Series	✓	x			
TM 5000/TM 500 Series					
TM 5003/ TM 503/TM 504	x	x	✓		x
TM 5006/ TM 506/TM 515				✓	x

✓—**Recommended** x—**Compatible**

LOAD CAPACITY/WEIGHTS

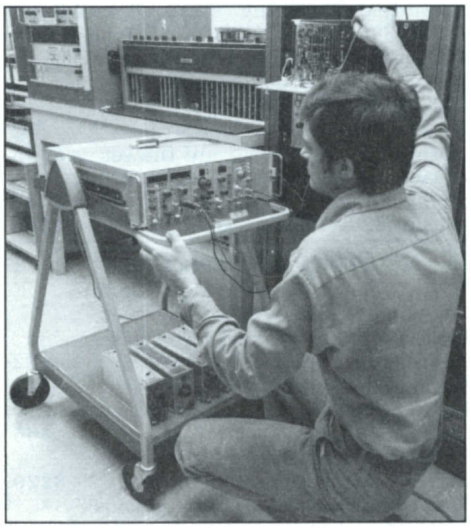
	K212		K213		K217		206	
Load Capacity	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Top Tray	36	80	34	75	45	100	45	100
Base	45	100	11	25	45	100	45	100
Hanging Shelf	—	—	18	40	—	—	—	—
Total	82	180	77	170	90	200	90	200
Weights ≈								
Net	9	20	26	57	20	43	14	30
Shipping	13	28	34	75	26	57	17	38
Dimensions: See dimensional drawings								
Page	503		504		504		503	
Prices	$350		$625		$510		$250	

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.



K213

K217



K217

K212

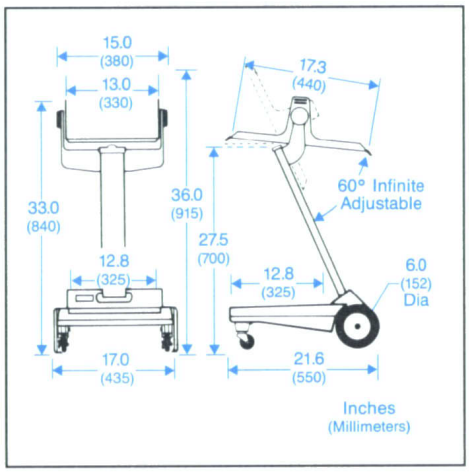
K212 Portable Instrument Cart

Typical Applications: On-site mobility of all portable instruments in medical facilities, labs, computer rooms, manufacturing areas, and other work areas.

The K212 provides a stable yet mobile platform for all Tek portable oscilloscopes and most other portable instruments. Tilting top tray, large locking front casters, and wide track base are standard features. Two bolt assembly required.

K212 Data Sheet 56-W-5835 is available.

CHARACTERISTICS



Construction—Base of thermoset polyester. Column and top of tray made of high-strength aluminum.

Color—Base and tray are Tek blue. Column and yoke are silver gray.

ORDERING INFORMATION

K212 Portable Instrument Cart **$350**

Includes: Two 1 in.×5 ft securing straps (346-0049-04); retaining bar (650-1881-00); two $^{3}/_{16}$ in. bolts; $^{3}/_{16}$ in. Hex key; instruction sheet (070-5554-00).

Special terms, conditions and discounts are available to qualified OEMs on the K212 and K217 carts. Contact your local Tektronix Sales Office.

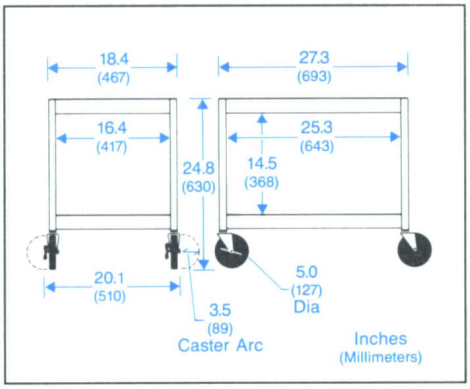
Model 206/206D

Utility Cart

Typical Applications: General purpose use and on-site mobility of general instruments, computer peripherals, laboratory and office use.

Features include a plastic laminate on both surfaces and brakes on front casters.

CHARACTERISTICS



ORDERING INFORMATION

206 Light Gray Finish **$250**

Includes: Instruction sheet (062-1408-02).

206D Brown Finish **$250**

Includes: Instruction sheet (062-6617-00).

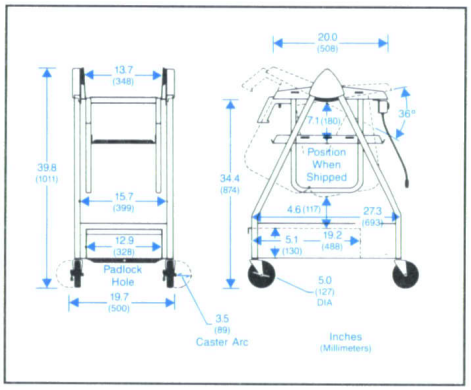
K217

K217 Rack Instrument Cart

Typical Applications: On-site mobility of most rackmountable or rack-width instruments. The ears of rackmountable instruments extend over the sides of tray.

Standard features include a tilting top tray, storage drawer under the top tray, a four outlet power strip, and front locking casters.

CHARACTERISTICS



Color—Tek blue with silver-gray legs.

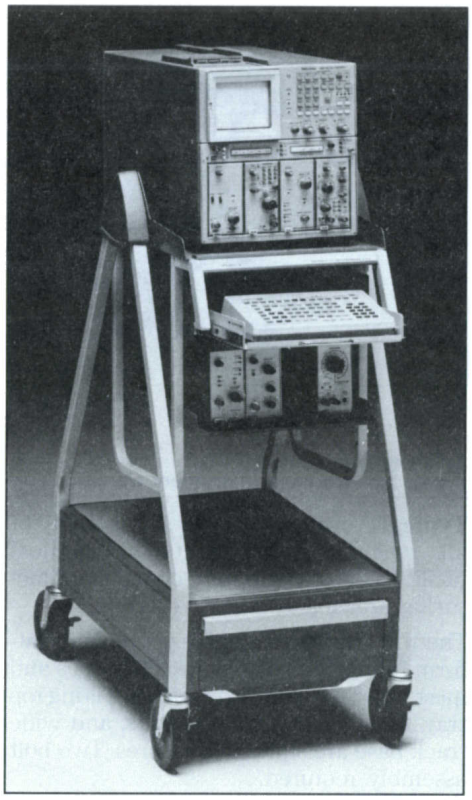
ORDERING INFORMATION

K217 Rack Instrument Cart **$510**
Includes: Instruction sheet (070-5653-00).
Option 01—Brown Finish **NC**

OPTIONAL ACCESSORIES (Fits K217 and 205/205D Carts)

Securing Strap—Nylon webbed, 1½ × 53 inch to secure instruments to top tray. Blue for K217. Order 346-0070-01 **$80**
Brown for K217 Option 01.
Order 346-0070-03 **$80**

Special terms, conditions and discounts are available to qualified OEMs on the K212 and K217 carts. Contact your local Tek Sales Office.



K213 shown with Option 22.

K213 Lab Instrument Cart

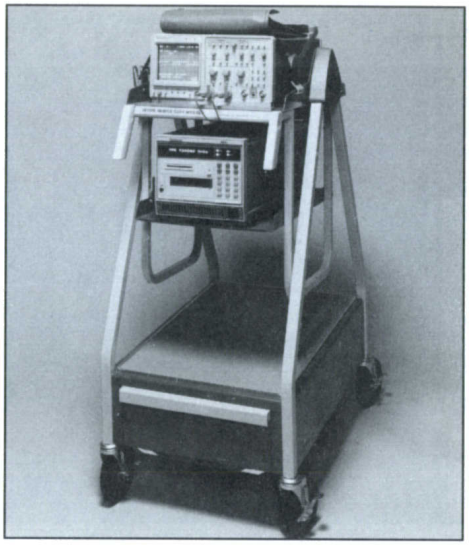
Typical Applications: On-site mobility of 5000 Series and 7000 Series Oscilloscopes in laboratory and manufacturing environments.

Standard features include tilting top tray, brakes on all casters, lockable drawer in the base, four-outlet power strip, 7000 Series scope lock-down bar, mounting hardware for TM 500 equipment and older scopes, a hanging shelf and a securing strap.

The hanging shelves are supported underneath and tilt with the top tray. These shelves are large enough to carry a TM 504 system or other small-to-medium sized test instruments. Slots in the shelves allow instruments to be secured with straps.

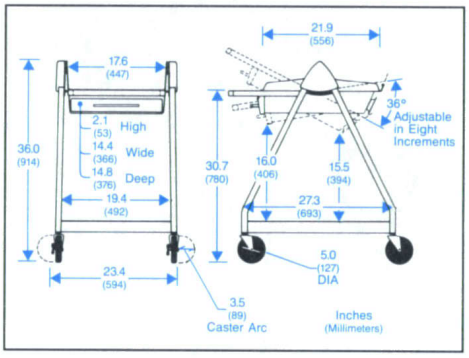
Option 10 provides a sliding drawer for use with the 7854 keyboard. The keyboard drawer mounts underneath the top tray and reduces available hanging shelf space by approximately three inches.

Option 12 gives an enclosure mounted on the standard shelf for storage of unused 5000 or 7000 Series plug-ins. The storage cabinet mounts on or under a shelf, but the option and kit do not include a shelf. Up to two storage cabinets can be installed at one time.



K213 shown with an MP 2601 system.

CHARACTERISTICS



Color—Tek blue with silver-gray legs.

ORDERING INFORMATION

K213 Lab Instrument Cart **$625**
Includes: Securing strap, 1½ × 42 in. (346-0136-01); shelf (436-0132-01); miscellaneous mounting adapters; four outlet, 115 V ac power strip; instruction sheet.

OPTIONS

Option 05—Delete Power Strip. **NC**
Option 10—7854 Keyboard Drawer. **+ $195**
Option 12—5000/7000 Series Plug-in Storage Cabinet. **+ $140**
Option 22—Combines Options 10/12. **+ $295**

OPTIONAL ACCESSORIES (Fits K213 and Model 3 Carts)

Securing Straps—Black nylon web, for use on top tray, shelves, or base.
(1½ × 42 in.) Order 346-0136-01 **$32**
(1½ × 57 in.) Order 346-0156-01 **$27**
Extra Shelf—Mounts below top tray. Order 436-0132-01 **$65**
7854 Keyboard Drawer Kit—Mounts under top tray. Order 436-0197-00 **$220**
Plug-In Storage Cabinet Kit—Mounts on or under hanging shelves. Does not include shelf. Order 436-0196-00 **$155**
Retaining Bar—Prevents sliding of portable scope on top tray or shelf when secured by straps. Mounting hardware included. Order 650-1881-00 **$12**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

THE STRONGEST LINK BETWEEN YOUR TEK INSTRUMENT AND RESULTS

Tek instruments are designed for users who place a premium on equipment quality and on reliability of results. Tek probes are engineered, assembled and tested to provide the most compatible link possible between tests instruments and the circuits under test.

THE ABCs OF PROBES

This comprehensive primer on signal acquisition probes contains sections on understanding probe specifications and applications and how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature 60-W-6053 or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

PROBE AND SIGNAL CONCEPTS

A video tape and 40-page booklet describes practical uses of passive, active and current probes. Emphasis is on selecting the correct probe for your application.

See pages 334-340 for additional educational products.

PROBES: SELECTION CRITERIA

No factor is more critical to optimized system performance than proper probe selection. A probe that's not right for your application can mean a significant loss in measurement results, plus costly delays and errors.

For over 35 years, Tektronix has been designing probes that are matched not only to our scopes, but to your own instrument and application needs. They minimize circuit loading, while extending and enhancing system performance.

By extending our resistive-wire, center-conductor cable technology, Tek 10X Passive probes can transfer a signal frequency that exceeds 300 MHz and presents only an added 3 pF per meter of cable to a circuit.

Tek probe products include active and passive voltage probes, active and passive current probes, high voltage probes, low impedance/high frequency probes, and differential probes.

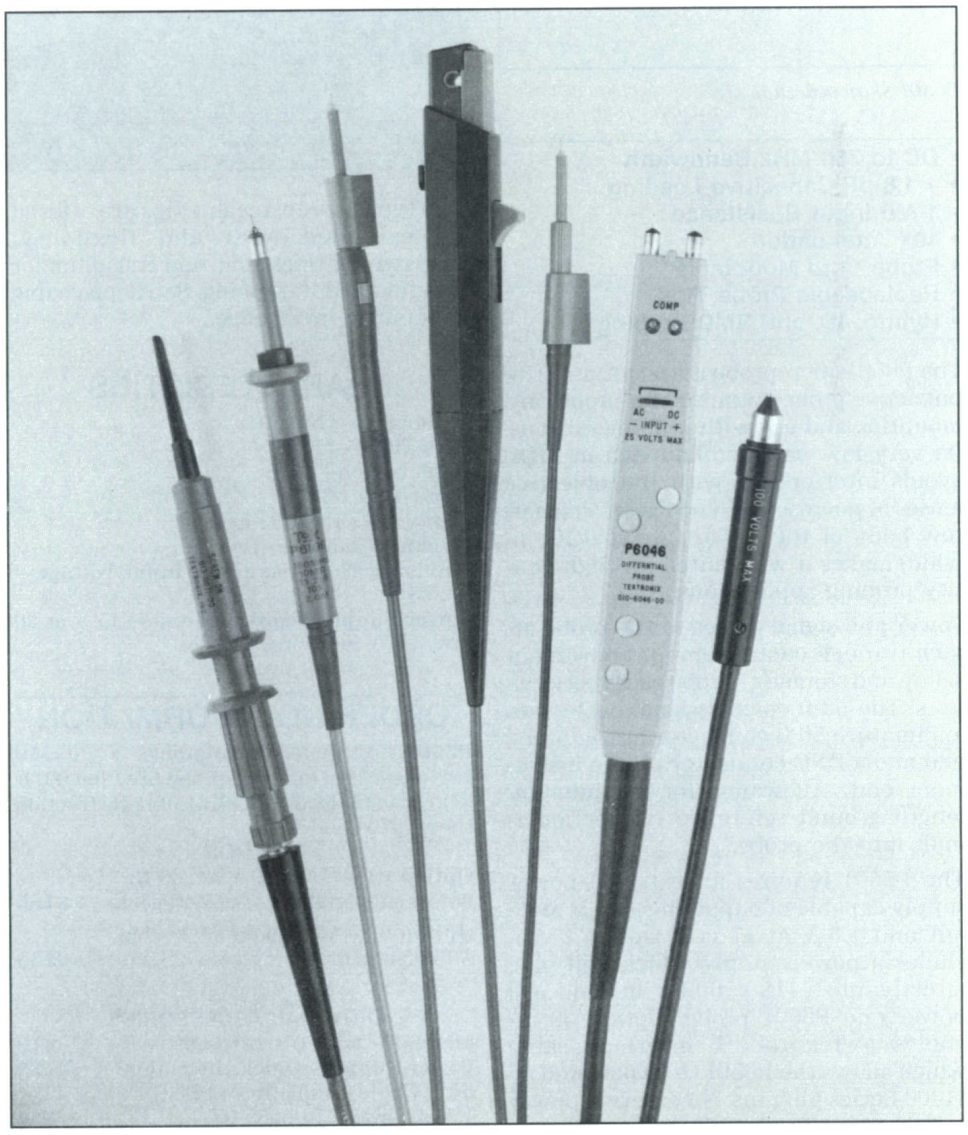
Bandwidth/rise time, input voltage, input impedance/circuit loading and aberrations are all characteristics to evaluate in terms of your own application.

While electrical considerations are of major importance in your selection, physical parameters, such as probe length and proper tip adapter, can be equally crucial. Unnecessary cable length, for example, will decrease bandwidth and increase the loading capacitance of the probe.

You'll find a wide variety of adapters and probe tips available which feature Tek's special alloy coating that minimizes low current conduction problems. All are inherent to the Tek modular probe concept that lets you snap tips and other probe parts together without tools, so maintenance and repair of damaged probes is of minimal expense.

CONTENTS

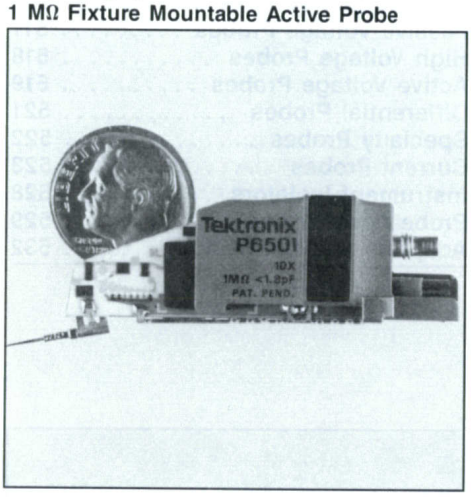
Fixtured Microprobes 506
Passive Voltage Probes 511
High Voltage Probes 518
Active Voltage Probes 519
Differential Probes 521
Specialty Probes 522
Current Probes 523
Instrument Isolators 528
Probe Accessories 529
Adapters and Connectors 532



FIXTURED MICROPROBES FOR IC, HYBRID, AND SMD CIRCUITS

P6501

1 MΩ Fixture Mountable Active Probe



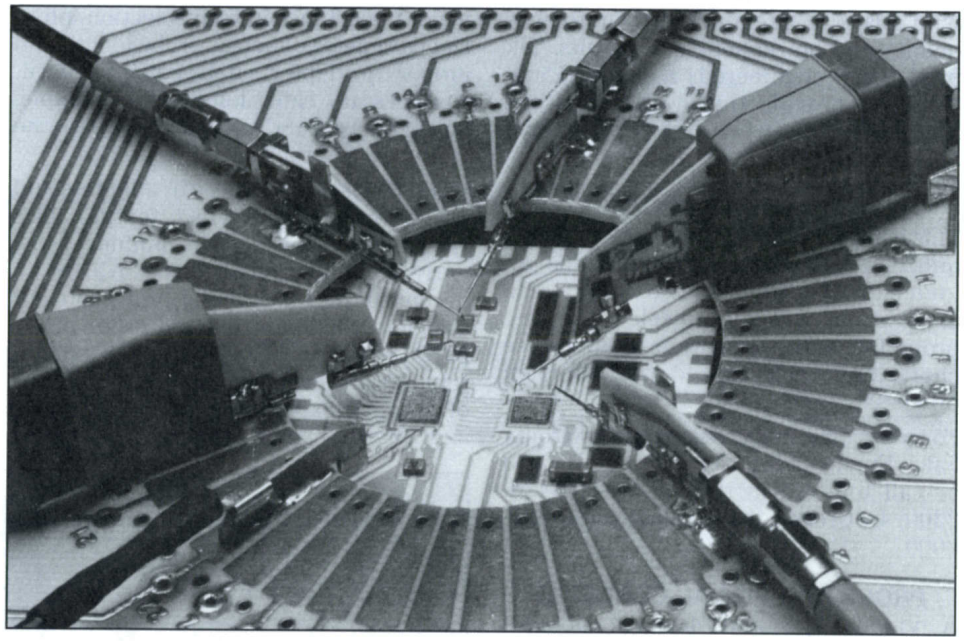
P6501 shown actual size

- **DC to 750 MHz Bandwidth**
- **<1.8 pF Capacitive Loading**
- **1 MΩ Input Resistance**
- **10X Attenuation**
- **Probe Card Mountable**
- **Replaceable Probe Tips**
- **Hybrid, IC, and SMD Probing**

The P6501 Microprobe is a small, 1 MΩ input active probe optimized for probe card mounting and use with probing stations. Its very low profile (about 0.5 in high) avoids interference with the objective lenses of microscopes and lasers. The narrow body of the P6501 (about 0.100 in wide) makes it well suited for high density probing applications.

Power and signal cables to the probe attach through connectors for convenient set up and storage of probe cards between uses. The 50 Ω coaxial signal cable uses a miniature 50 Ω connector at the probe end and a BNC connector on the instrument end. Allowance for a minimum-length ground reference connection is built into the probe.

The P6501 requires an external power supply capable of supplying ±15 V at 20 mA and ±5 V at 17 mA. Option 01 includes a power supply which will plug directly into a 115 V, 60 Hz line and will power one P6501 probe. Option 02 includes a Tekprobe™ interface cable which allows the P6501 to be powered by 11000 Series plug-ins. No external power supply is required with Option 02.



Two types of replaceable tips are offered for extended wear and flexibility: Tungsten for thick film, and Palladium for thin film and IC probing. See Replaceable Tips on the next page.

CHARACTERISTICS

Bandwidth—750 MHz.
Rise Time—450 ps.
Attenuation—10X.
Input R—1 MΩ.
Input C—≤1.9 pF.
Dynamic Range—±10 V.
Maximum Nondestructive Input Voltage—±26.5 V.
Power Supply Requirements—±15 V at 20 mA, ±5 V at 17 mA.

ORDERING INFORMATION

P6501 1 MΩ Active Microprobe **$450**
Includes: Two tungsten probe tips (206-0371-01); ground lead (196-3141-00); instruction sheet (070-6300-00).

OPTION

Option 01— Add 110 V ac, 60 Hz power supply and 1.5 m 50 Ω cable. **+$155**

Option 02—Add Tekprobe™ cable (015-0540-00). **+$155**

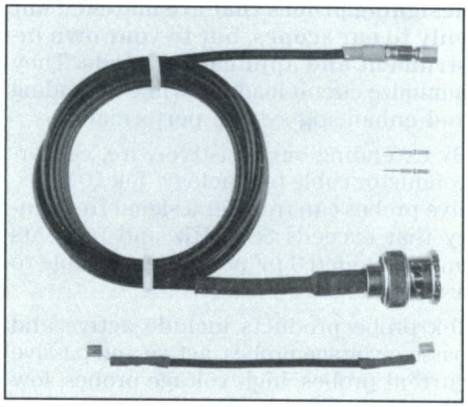
OPTIONAL ACCESSORIES

Manual—Order 070-6188-00 **$10**
Power Supply—Order 119-2461-00 **$125**
50 Ω Cable—Miniature to BNC, 1.5 m. Order 174-0538-00 **$30**
Ground Lead Assembly—Order 196-3141-00 **$6**

REPLACEABLE TIPS

The P6507/P6501 use the same replaceable tips and connectors. The replaceable tips offer versatility and long life. Both tungsten and palladium tips are available, conveniently plugging into the probe's input receptacle. Tips can be easily replaced as they wear, or as different applications dictate. Tips are available in two lengths. Standard tips extend 0.200 in. from the connector plug. Long tips extend 0.458 in. from the connector plug.

Tungsten Probe Tip—Pkg of 5.
Order 206-0371-02 **$28**
Palladium Probe Tip—Pkg of 5.
Order 206-0370-02 **$28**



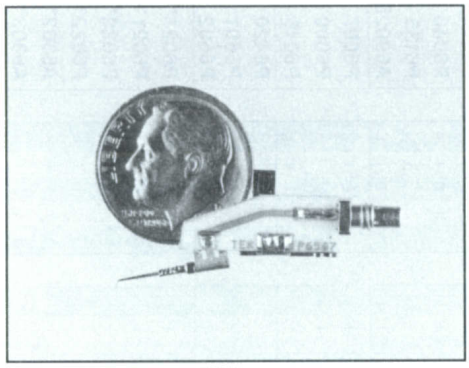
Optional accessories for P6501/P6507 microprobes.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

FIXTURED MICROPROBES FOR IC, HYBRID, AND SMD CIRCUITS

P6507

50 Ω Fixtured Mountable Probe



P6507 shown actual size.

- **DC to 1 GHz Bandwidth**
- **50 Ω Input**
- **1X Attenuation**
- **Probe Card Mountable**
- **Replaceable Probe Tips**
- **Hybrid, IC, and SMD Probing**

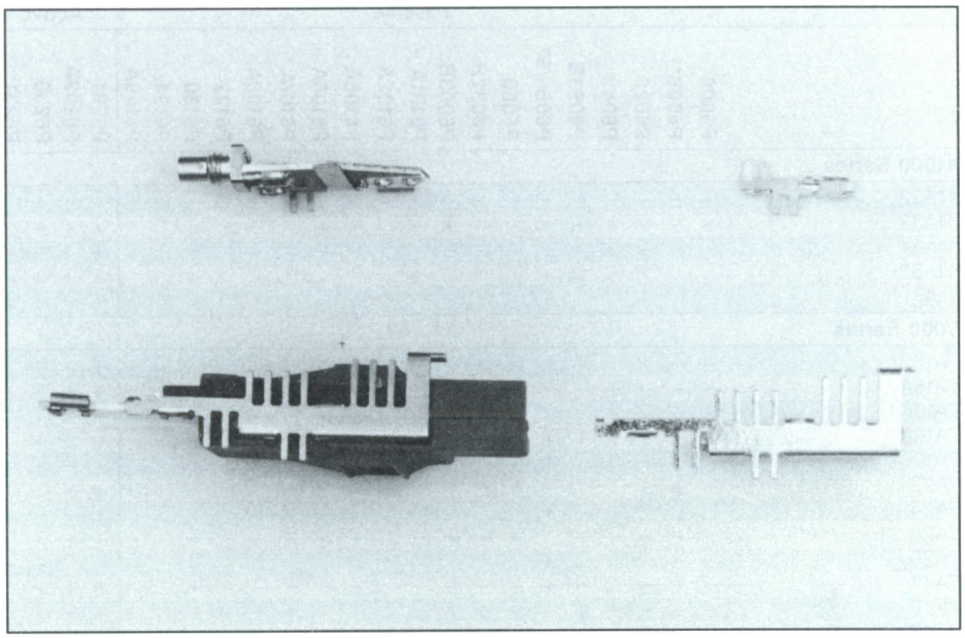
The P6507 Microprobe is a 50 Ω input probe and companion to the P6501. The probe can be used as either a 50 Ω input or output probe in card-mounted applications. It consists of a 30 mil thick Alumina hybrid substrate with a 50 Ω stripline. Note: Due to the utilization of 50 Ω stripline, DC blocking and other customizing modifications are possible by the user. The P6507 uses the same replaceable tips, cables, and connectors as the P6501.

The P6507 maintains a low profile thus allowing use of multiple probes in dense microprobing of hybrids, wafers, and other high density circuits.

The P6507 uses industry standard microminiature connectors to help eliminate troublesome hand soldering coaxial cables to the microprobes.

CHARACTERISTICS

Bandwidth—1 GHz.
Rise Time—<350 ps.
Attenuation—1X.
Input R—50 Ω.
Input C—55 pF.
Maximum Nondestructive Input Voltage—±42.5 V.



Shown above is the P6507 entire probe (top left), base (right), and P6501, entire probe (lower left), base (right).

ORDERING INFORMATION

P6507 50 Ω Microprobe **$50**
Includes: One tungsten probe tip (206-0371-01); instruction sheet (070-6301-00).

OPTION

Option 01—Add 0.5 m 50 Ω cable. **+$30**

OPTIONAL ACCESSORIES

50 Ω Cable—Miniature to BNC 0.5 m. Order 174-0668-00 **$30**
Ground Lead Assembly—Order 196-3141-00 **$6**

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Tungsten Probe Tip—Pkg of 5. Order 206-0371-02 **$28**
Palladium Probe Tip—Pkg of 5. Order 206-0370-02 **$28**
Tip connector plug—Allows alternate tips or leads for device under test interconnection. Order 131-3816-01 **$15**

A PROBE FOR VIRTUALLY EVERY APPLICATION

Tektronix offers many probes for your different probing requirements. This guide lists those probes which offer the best performance match, along with other usable combinations.

	Passive																			Active				Differ-ential				High Voltage			Spe-cialty			Current					
	P6006	P6008*3	P6028	P6048	P6053B	P6056/57	P6060	P6062B	P6063B	P6101A	P6102A	P6105A	P6106A	P6107A	P6108A	P6122	P6130	P6134	P6149A	P6201	P6202A	P6230	P6231	P6055*4	P6046	P6135	A6902B	P6007	P6009	P6015	P6420	P6601	P6602	P6021*1	P6021*2	P6022*1	P6022*2	A6302*5	A6303*5
11000 Series																																							
11A32	–	–	–	–	–	+	–	–	–	–		–	–		–	–	–	✓		+	+	+			–		–	–		–			–	–	–	–	–	–
11A33	–	–	–	–	+	+	–	–	+	–		–	+		–	–	+			+	+	+			–	✓	–	–		–			–	–	–	–	–	–
11A34	–	–	–	–	–	+	–	–	–	–		–	–			–	–	✓		+	+	+			–		–	–		–			–	–	–	–	–	–
11A52						+														+	+	+	✓		–		–							–		–	–	–
11A71						+														–	–	+	✓		–		–							–		–	–	–
7000 Series																																							
7A13	–	–	–		+		–	+	–	–		✓	+	–	–	–	+		–	+	+	+		✓	–		–	–	+	–				–	–	+	–	–	–
7A15A	–	+	–	+	+		–	+	+	–		+	+	+	+	+	+		–	+	+	+		–	+		–	–	+	–				–	–	+	–	–	–
7A16A	–	–	–	–	–		–	–	–	–		–	✓	–	–	–	+		–	+	+	+		–	–		–	–	–	–				–	–	–	–	–	–
7A18A	–	+	–	+	+		–	+	+	–		✓	+	+	+	+	+		–	+	+	+		–	+		–	–	+	+				–	–	+	–	–	–
7A19						+														+	–	+			–		–								–		–	–	–
7A22	+	+	+				+	+	+	+	+			+					+	+	+			✓	+		+	+	+					+	+	+	+	+	+
7A24						+														+	+	+			–	–									–		–	–	–
7A26	–	–	–	–	+		–	–	✓	–		–	✓	–	–	–	+		–	+	+	+		–	–		–	–	–	–				–	–	+	–	–	–
7A29						+														–	–	+			–	–									–		–	–	–
7A42	–	–	–		–	+	–	–	–	–		–	–	–	–	–	–			+	+	✓					–	–	–	–				–	–	–	–	–	–
7D12	+	+	–	+	+		+	+	+	+		+	+	+	+	+	+		+	+	+	+		✓	+		–	+	+	+				+	+	+	+	+	–
7D13A																															✓	✓							
7D20	–	+	–	+	+		–	+	+	–		+	+	+	+	+	+		–	+	+	+		–	+			–	+	+				–	–	–	–	–	–
5000 Series																																							
5A13N	+	+	+				+	+		+	+			+					+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
5A14N/5N/8N	+	+	+				+	+		+	✓			+					+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
5A21N	+	+	+				+	+		+	✓			+					+	+	+	+		✓	+		+	+	+	+				✓	+	+	+	+	+
5A22N	+	+	+				+	+		+	+			+					+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
5A26	+	+	+				+	+		+	✓			+					+	+	+	+		✓	+		+	+	+	+				+	+	+	+	+	+
5A38	+	+	–	+	+		+	+	+	–		✓	+	+	+	+	+		+	+	+	+		+	+		–	–	+	+				+	+	+	+	+	–
5A45	–	+	–	+	+		–	+	+	–		+	+	+	+	+	+		–	+	+	+		+	+		–	–	+	+				+	–	+	+	–	–
5A48	–	+	–	+	+		–	+	+	–		✓	+	+	+	+	+		+	+	+	+		+	+		–	–	+	+				+	–	+	+	+	–
5D10	+	+	+				+	+		–				+					+	+	+	+		+	+		+	–	+	+				+	+	+	+	+	+
TM 500 Series																																							
AM 502	+	+	+				+	+		+				+					+	+	+	+		✓	+		+	+	+	+				✓	+	+	+	+	+
AM 503																																						✓	✓
DM 501A																															✓	+							
DM 502A																															✓	+							
DM 505																															✓	+							
SC 501	+	+	+				+	+		+	✓			+					+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
SC 502	+	+	+				+	+		+	✓			+					+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
SC 503	+	+	+				+	+		+	✓			+					+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
SC 504	–	+	–	+	+		–	+	+	–		+		+	+	+	+		–	+	+	+		–	+		–	–	+	–				–	–	+	–	–	–
TM 5000 Series																																							
DC 5009	–	–	–				–	–		–		–		–	–	–	+		–	+	+	+		–	–		–	–	–	–				–	–	+	–	–	–
DC 5010	–	–	–	–	–	+	–	–	–	–		–		–	–	–	–		–	+	+	+		–	–		–	–	–	–				–	–	–	–	–	–
DM 5010																															+								
SI 5010						+														+	+	+			–		–								–		–	–	–

✓ *Indicates recommended combinations of probe and instrument.*
\+ *Indicates usable combinations where probe bandwidth exceeds that of instrument.*
– *Indicates combinations where probe limits system specifications.*
Blank indicates unusable combinations.

*1 *With Termination*
*2 *With 134 Amplifier*
*3 *Environmental Probe*
*4 *Matched pair 015-0437-00*
*5 *With AM 503*

THE ABCs OF PROBES

This is a comprehensive booklet discussing signal acquisition probes with sections on understanding probe specifications, probe applications, and how to select the best probe for your application. Includes easy to use charts and tables to help speed your selection process for the correct probe for your signal acquisition needs.

For your free copy, ask your Tektronix Sales Engineer for Literature 60-W-6053 or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

	Passive																								Active			Differ-ential			High Voltage			Spec-ialty		Current					
	P6006	P6008*3	P6028	P6048	P6053B	P6056/57	P6060	P6062B	P6063B	P6101A	P6102A	P6103	P6105A	P6106A	P6107A	P6108A	P6109	P6121	P6122	P6130	P6131	P6133	P6136	P6149A	P6201	P6202A	P6230	P6055*4	P6046	A6902B	P6007	P6009	P6015	P6420	P6602	P6021*1	P6021*2	P6022*1	P6022*2	A6302*5	A6303*5
T900 Series																																									
T912/21	✓	+	+				+	+		+			+		+	+			+	+				+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
T922R	✓	+	+					+	+	+			+		+				+					+			+	+	+	+	+	+	+			+	+	+	+	+	+
T932A/35A	✓	+	–				+	+		–			+		+	✓			+	+				+	+	+	+	+	+	–	–	+	+			+	+	+	+	+	–
300 Series																																									
305/14	+	+	+				+	+		+	+				+									✓	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
323	+	+	+				+	+		+			+		+					+				+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
326	+	+	+				+	+		+	+		+		+	+				+				+	+	+	+	+	+	+	+	+			+	+	+		+	+	+
335	+	+	–	+	+		+	+	+	–			+	+	+	+			+	+				✓	+	+	+	+	+	–	–	+	+			+	+	+	+	+	–
336	+	+	+				+	+		+			+		+	+			+	+				+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
390AD D	+	+	–	+	+		+	+	+	+				+	+				+	+				+	+	+	✓	+	+	–	–	+	+			+	+	+	+	+	+
390AD S	–	+	–	+	+		–	+	+	–				+	+				+	+				–	+	+	+	+	+	–	–	+	+			+	–	+	+	–	–
400 Series																																									
434	+	+	–	+	+		+	+	+	+			✓	+	+	+			+	+				+	+	+	+	+	+	–	+	+	+			+	+	+	+	+	–
455	–	+	–	+	+		–	+	+	+			✓	+	+	+			+	+				+	+	+	+	+	+	–	–	+	+			+	–	+	+	+	–
464	–	+	–	+	+		–	✓	+	–			✓	+	+	+			+	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
465/M	–	+	–	+	+		–	+	+	–			+	+	+	+			+	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
465B	–	+	–	+	+		–	+	+	–			✓	+	+	+			+	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
466	–	+	–	+	+		–	✓	+	–			✓	+	+	+			+	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
475	–	–	–	–	+		–	–	+	–			–	✓	–	–			–	+				–	+	+	+	–	–	–	–	–	–			–	–	+	–	–	–
475A	–	–	–	–	–		–	–	–	–			–	✓	–	–			–	+				–	+	+	+	–	–	–	–	–	–			–	–	–	–	–	–
485	–	–	–	–	–	+	–	–	–	–			–	✓	–	–			–	✓				–	+	+	+	–	–	–	–	–	–			–	–	–	–	–	–
2400 Series																																									
2430A	–	–	–	–	–	+	–	–	–	–			–	–	–	–			–	–	+	✓			+	+	+		–	–	–	–	–			–	–	–	–	–	–
2445A	–	–	–	+	+	+	–	–	+	–			–	+	–	–			–	+	+	✓			+	+	+		–	–	–	–	–	✓	✓	–	–	+	–	–	–
2455A	–	–	–	–	–	+	–	–	–	–			–	–	–	–			–	–	✓		✓		+	+	+		–	–	–	–	–	✓	✓	–	–	–	–	–	–
2445	–	–	–	+	+	+	–	–	+	–			–	+	–	–			–	+	✓				+	+	+		–	–	–	–	–	✓	✓	–	–	+	–	–	–
2465	–	–	–	–	–	+	–	–	–	–			–	–	–	–			–	–	✓				+	+	+		–	–	–	–	–	✓	✓	–	–	–	–	–	–
2467	–	–	–	–	–	+	–	–	–	–			–	–	–	–			–	–	–		✓		+	+	+		–	–	–	–	–			–	–	–	–	–	–
2465A	–	–	–	–	–	+	–	–	–	–			–	–	–	–			–	–	✓				+	+	+		–	–	–	–	–	✓	✓	–	–	–	–	–	–
2200 Series																																									
2213A/15A	–	+	–	+	+		–	+	+	–			+	+	+	+			✓	+				–	+	+	+	+	+	–	–	+	+			+	–	+	+	–	–
2221	–	+	–	+	+		–	+	+	–			+	+	+	+			✓	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
2225	–	+	–	+	+		–	+	+	–		✓	+	+	+	+			+	+				✓	+	+	+	+	+	–	–	+	+			+	–	+	+	–	–
2235/20	–	+	–	+	+		–	+	+	–			+	+	+	+	+		✓	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
2236/30	–	+	–	+	+		–	+	+	–			+	+	+	+	+	✓	+	+				–	+	+	+	–	+	–	–	+	–	✓	✓	–	–	+	–	–	–
2245/46	–	–	–	–	+		–	–	+	–			–	+	–	–	✓		–	+				–	+	+	+	–	–	–	–	–	–			–	–	+	–	–	–
2300 Series																																									
2335	–	+	–	+	+		–	+	+	✓			+	+	+	✓			+	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
2336	–	+	–	+	+		–	+	+	✓			+	+	+	✓			+	+				–	+	+	+	–	+	–	–	+	–			–	–	+	–	–	–
2337	–	+	–	+	+		–	+	+	✓			+	+	+	✓			+	+				–	+	+	+	–	+	–	–	+	–	✓	✓	–	–	+	–	–	–

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See the Difference

The photos at right show signals measured with Tek probes and their commodity counterparts. To get the best performance from your measurement system, use Tek probes!

GLOSSARY

Aberrations—Deviation from a theoretically correct response to an input signal. Measured in + and − deviation from the final level (flat top).

A-S Product (Amp Second)—A figure of merit applied to current probes when operated under pulse-type conditions. When the peak current times the pulse width exceeds the A-S rating, the core will tend to saturate and clip portions of the displayed signal.

Bandwidth—Tek probe bandwidth specifications assume scope bandwidth "at the probe tip" unless otherwise noted. The probe bandwidth must be equal to or greater than the specified scope bandwidth. (All BW figures refer to the −3 dB point.)

Compensation Range—The range of the scope's amplifier input capacitances for which you can compensate your probe.

Circuit Loading—A function of total probe impedance at a specific frequency. Probe tip capacitance is the major contributor to circuit loading as frequencies increase or risetimes decrease.

Common-Mode Rejection Ratio (CMRR) Measurement of a probe/differential amplifier's ability to reject common-mode signals. With a system CMRR of 10,000:1, a 10 V common-mode input signal will be attenuated to 1 mV at the output and the differential (desired) signal will be amplified times the system gain.

Derating—Passive voltage probes maximum input voltage is derated after a specific upper frequency. AC current probes upper and lower frequency derating points are specified for maximum continuous currents.

Dynamic Range—Applies to Active (FET) probes. Specified as the maximum linear as operating range in volts.

Insertion Impedance—Associated with current probes describing the loading effect in Ω (Z) at some specific frequency.

Maximum Input Voltage—Maximum allowable input at the probe tip. Specified as dc + peak ac.

Maximum AC Current (CW)—Maximum continuous current handling ability of a current probe. Derated with frequency.

Maximum Peak Pulse Current—Maximum peak current handling ability of a current probe. Always greater than the maximum continuous current rating. Controlled by the Amp-Second product.

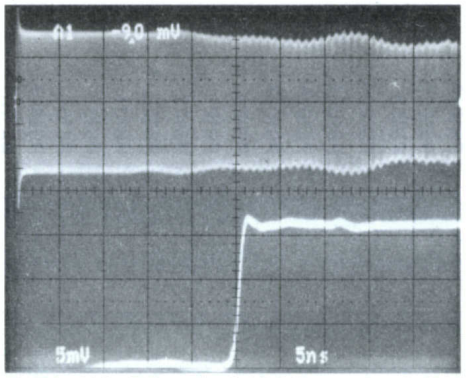
Maximum Peak Pulse Voltage—Maximum peak voltage handling ability of high voltage probes. Specification carries pulse width and duty cycle restrictions.

Rise Time—A probe's 10 to 90% response to a step function.

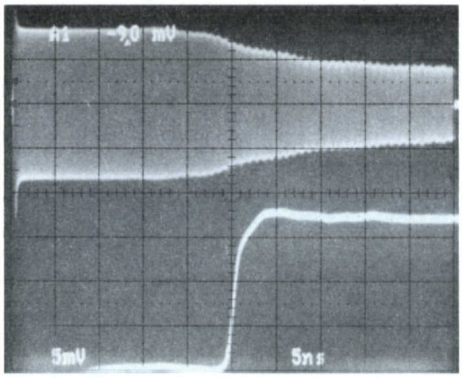
Ringing—Damped oscillation response usually caused by inductive effects of poor probe grounding techniques.

Tangential Noise—A practical method of specifying probe generated noise (active probes). Tangential noise figures are approximately two times RMS noise.

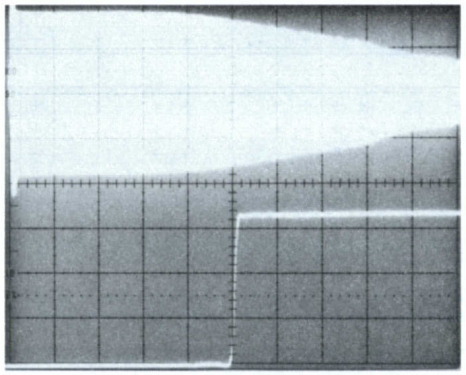
Optimum Performance With Tek | **Loss With Commodity Probe**



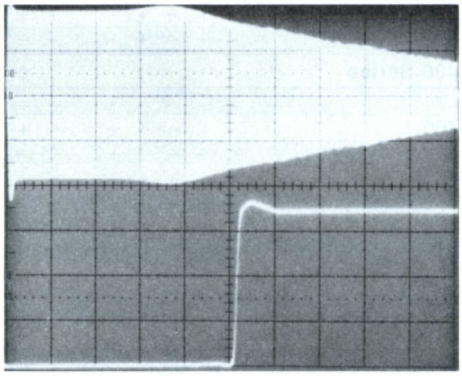
Bandwidth: Tek probe faithfully transmits 300 MHz signal.



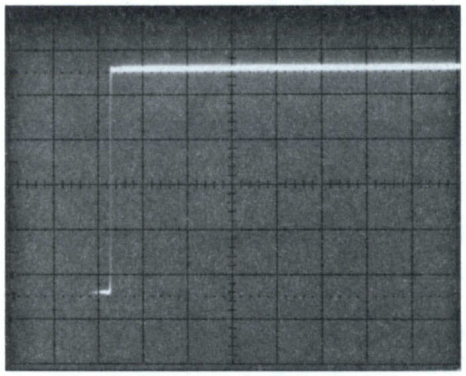
Commodity probe limits same signal to 200 MHz.



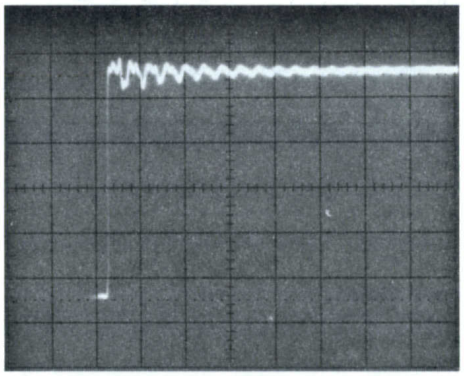
Frequency Response: Tek probes evenly matched for clear response.



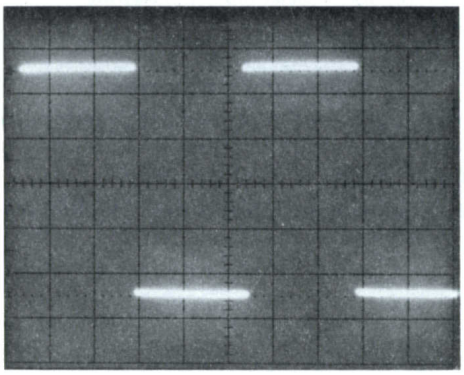
Commodity probe peaked resulting in aberrations.



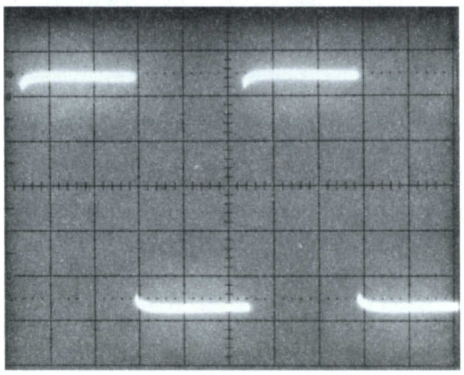
Probe Tip Accessories: Ringing does not exist with the appropriate ground lead from Tek.



Commodity probes may not have the right accessories to make a faithful measurement.



Environmental: Tek offers superior performance. No signal degradation after five days in high humidity.



Commodity probe shows "hook" after same humidity test.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

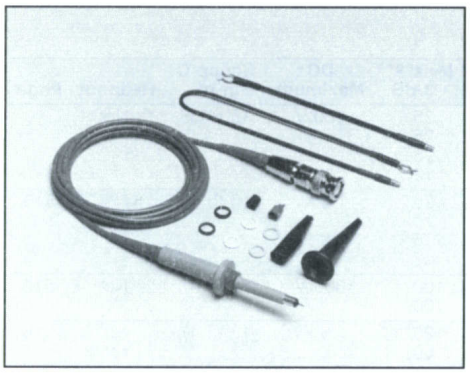
PASSIVE PROBES

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For frequencies lower than 5 MHz, the resistive component is usually the most important and should be at least two orders of magnitude greater than the circuit source impedance. For frequencies higher than 30 MHz, the capacitance becomes the prime consideration. These probes offer a wide selection for a variety of applications for 1 MΩ inputs.

Type	Attenuation	Length*1	Old Package Number	New Package Number	Loading		BW MHz*2*4 at −3 dB	DC Maximum	Scope C in pF	Readout	Page
P6006	10X	3.5 ft	010-0127-00	P6006 Opt 01	10 MΩ	7.5 pF*2	35	600 V	15 to 55	No	—
		6 ft	010-0160-00	P6006		8.5 pF	25				
		9 ft	010-0146-00	P6006 Opt 03		11.0 pF	25				
		12 ft	010-0148-00	P6006 Opt 04		15.0 pF	12				
P6007	100X	3.5 ft	010-0150-00	P6007 Opt 01	10 MΩ	2.0 pF*2	25	1.5 kV	15 to 55	No	518
		6 ft	010-0165-00	P6007		2.2 pF	20				
		9 ft	010-0152-00	P6007 Opt 03		2.4 pF	15				
		12 ft	010-0154-00	P6007 Opt 04		2.6 pF	13				
P6008	10X	3.5 ft	010-0129-00	P6008 Opt 01	10 MΩ	7.5 pF	100	600 V	12 to 47	No	515
		6 ft	010-0129-01	P6008 (Environmentalized)			100				
P6009	100X	9 ft	010-0170-00	P6009 Opt 14	10 MΩ	2.5 pF	120	1.5 kV	12 to 47	No	518
		9 ft	010-0264-01	P6009		2.5 pF	100			Yes	
P6015	1000X	10 ft	010-0172-00	P6015	100 MΩ	3.0 pF	75	20 kV	12 to 47	No	518
P6028	1X	3.5 ft	010-0074-00	P6028 Opt 01	1 MΩ	50.0 pF	17	600 V	Any	N/A (IX)	—
		6 ft	010-0075-00	P6028		67.0 pF	10				
		9 ft	010-0076-00	P6028 Opt 03		90.0 pF	7				
		12 ft	010-0077-00	P6028 Opt 04		112.0 pF	4				
P6048	10X	6 ft	010-0215-00	P6048	1 kΩ	1.0 pF	100	20 V	15 to 20	No	515
P6053B	10X	3.5 ft	010-6053-11	P6053B Opt 01	10 MΩ	9.5 pF	200	500 V	15 to 24	Yes*5	514
		6 ft	010-6053-13	P6053B		12.5 pF	200				
		9 ft	010-6053-15	P6053B Opt 03		13.5 pF	115				
P6055*3	10X	3.5 ft	010-6055-01	P6055 Opt 01	1 MΩ	10.0 pF	60	500 V	20 to 47	Yes	521
P6056	10X	6 ft	010-6056-03	P6056	500Ω	1.0 pF	3500	16 V	N/A (50Ω)	Yes	515
P6057	100X	6 ft	010-6057-03	P6057	5 kΩ	1.0 pF	1400	50 V	N/A (50Ω)	Yes	515
P6062B	10X or 1X	3.5 ft	010-6062-11	P6062B Opt 01	10 MΩ	13.5 pF	100	500 V	15 to 47	Yes	514
					1 MΩ	100.0 pF	8				
	10X or 1X	6 ft	010-6062-13	P6062B	10 MΩ	14.0 pF	100				
					1 MΩ	105.0 pF	6				
	10X or 1X	9 ft	010-6062-15	P6062B Opt 03	10 MΩ	17.0 pF	95				
					1 MΩ	135.0 pF	4.5				
P6063B	10X or 1X	3.5 ft	010-6063-11	P6063B Opt 01	10 MΩ	11.0 pF	200	500 V	15 to 24	Yes	514
					1 MΩ	80.0 pF	12				
	10X or 1X	6 ft	010-6063-13	P6063B	10 MΩ	14.0 pF	200				
					1 MΩ	105.0 pF	6				
P6101A	1X	1 m	010-6101-11	P6101A Opt 01	1 MΩ	32.0 pF	34	500 V	Any	N/A (IX)	512
		2 m	010-6101-13	P6101A		54.0 pF	15				
		3 m	010-6101-15	P6101A Opt 03		78.0 pF	8				
P6102A	10X	2 m	P6102A	P6102A	10 MΩ	13.2 pF	60	500 V	36 to 55	Yes	512
P6103	10X	2 m		P6103	10 MΩ	13.2 pF	50	500 V	15-35 pF	No	513
		1 m		P6103 Opt 01		10.9 pF	50				
		3 m		P6103 Opt 02		15.5 pF	50				
P6104A	10X	1 m	010-6104-11	P6104A	10 MΩ	11.2 pF	100	500 V	15 to 35	No	—
P6105A	10X	1 m	010-6105-11	P6105A Opt 01	10 MΩ	8.7 pF	100	500 V	15 to 35	Yes	512
		2 m	010-6105-13	P6105A		11.2 pF	100		15 to 35		
		3 m	010-6105-15	P6105A Opt 03		13.2 pF	90		15 to 30		
P6106A	10X	1 m	010-6106-11	P6106A Opt 01	10 MΩ	8.7 pF	250	500 V	15 to 35	Yes	512
		2 m	010-6106-13	P6106A		11.2 pF	250		15 to 35		
		3 m	010-6106-15	P6106A Opt 03		13.2 pF	150		15 to 30		
P6107A	10X	2 m	010-6107-13	P6107A	10 MΩ	13.0 pF	100	500 V	20 to 51	Yes	512
P6108A	10X	1 m	010-6108-11	P6108A Opt 01	10 MΩ	8.7 pF	100	500 V	15 to 35	No	512
		2 m	010-6108-13	P6108A		11.2 pF	100		15 to 35		
		3 m	010-6108-15	P6108A Opt 03		13.2 pF	90		15 to 30		
P6109	10X	2 m		P6109	10M Ω	13.2 pF	150	500 V	18-22 pf	Yes	513
		1.5 m		P6109 Opt 01		11.0 pf	150				
		3 m		P6109 Opt 02		15.5 pf	100				
P6121	10X	1.5m	010-6121-01	P6121	10 MΩ	11.0 pF	100	500 V	20 to 26	Yes	513
P6122	10X	1.5m	010-6122-01	P6122	10 MΩ	11.0 pF	100	500 V	15 to 35	No	513
		2 m	010-6122-03	P6122 Opt 02		12.0 pF	100				
		3 m	010-6122-05	P6122 Opt 03		14.0 pF	90				
P6125	5X	1.5m	010-6125-11	P6125	5 MΩ	20.0 pF	200	250 V	15 to 33	No	513
P6130*6	10X	1.5m	010-6130-01	P6130 Opt 01	10 MΩ	12.7 pF	250	500 V	15 to 35	Yes	516
		2 m	010-6130-03	P6130		13.2 pF	250		15 to 35		
		3 m	010-6130-05	P6130 Opt 03		14.5 pF	150		15 to 30		
P6148A	10X	2 m	010-6148-13	P6148A	10 MΩ	13.0 pF	50	500 V	20 to 51	No	—
P6149A	10X	2 m	010-6149-13	P6149A	10 MΩ	13.0 pF	50	500 V	20 to 51	No	512

*1 *All lengths are nominal and measured electrically for optimum performance.*
*2 *Rating varies with scopes having other than 20 pF inputs.*
*3 *Designed for use with scopes having differential inputs.*
*4 *25 Ω source.*
*5 *Trace identification button.*
*6 *P6131/P6133/P6136 probes are designed specifically for 2400 Series oscilloscopes.*

P6101A
DC to 34 MHz, 1X
Modular



MODULAR PROBES

Tektronix modular probes are designed to save you money in repair and maintenance over the life of the probe. The three modules (probe head, cable, and connector/compensation box) quickly snap or screw together eliminating the need for soldering. Spare modules can be ordered and stocked, reducing down-time and eliminating the need to send a probe in for repairs (see page 531). Modularity, rugged construction and highly reliable hybrid circuitry make these Tektronix probes a cost effective probing solution.

For 1 MΩ Input

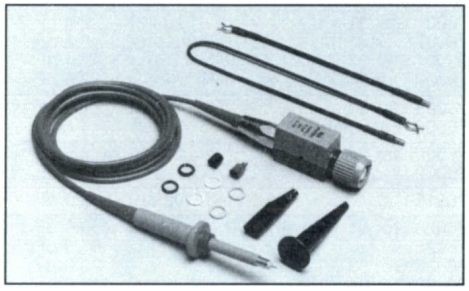
- **Simplified, Faster Maintenance and Repairs**
- **High Fidelity Signal Acquisition at Low Cost**
- **Hybrid Circuitry for Improved Performance**
- **Rugged for Greater Reliability**

P6102A
DC to 60 MHz, 10X
Modular
With Readout

P6106A
DC to 250 MHz, 10X
Modular
With Readout

P6105A
DC to 100 MHz, 10X
Modular
With Readout

P6108A
DC to 100 MHz, 10X
Modular



Tektronix modular passive probes are used to acquire high fidelity signals from low source impedance circuits. The P6102A, P6105A, P6106A and P6107A will automatically scale the readout on oscilloscopes equipped with this feature. All but the P6101A and P6108A provide a ground reference button on the probe head for quick trace identification. The P6107A and P6149A feature a right angle BNC connector.

Tektronix modular probes may be used with all oscilloscopes with 1 Mohm input impedance and appropriate input capacitance as indicated in the chart below. These probes are compatible with all miniature probe accessories.

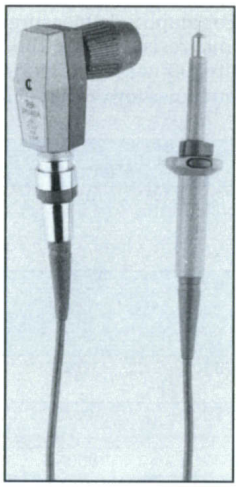
For probe accessories, see page 529.

For replaceable modular subassemblies, see page 531.

Instrument compatibility chart is on pages 508 and 509.

P6107A
DC to 100 MHz, 10X
Modular
With Readout

P6149A
DC to 50 MHz, 10X
Modular



ORDERING INFORMATION

P6101A 1X, 34 MHz, 2 m Modular Probe. **$53**
Includes: Retractable hook tip (B3, 013-0107-05); probe tip ground cover (B16, 166-0404-01); 5 in ground lead (175-0124-01); 12 in ground lead (G7, 175-0125-01); alligator clip (344-0046-00); two each of black, white and silver cable markers; instruction sheet (070-5299-00).

P6105A 10X, 100 MHz, 2 m Modular Probe. **$93**
Includes: Same as the P6101A plus adjustment tool (F3, 003-1364-01); instruction sheet (070-5516-00).

P6106A 10X, 250 MHz, 2 m Modular Probe. **$140**
Includes: Same as the P6105A except 3 in ground lead (G7, 175-0263-01) instead of 12 in ground lead; instruction sheet (070-5517-00).

P6108A 10X, 100 MHz, 2 m Modular Probe. **$75**
Includes: Same as the P6105A; instruction sheet (070-5519-00).

OPTIONS

Option 01—1 m cable. **NC**
Option 03—3 m cable. **NC**

P6102A 10X, 60 MHz, 2 m Modular Probe **$65**
Includes: Same as the P6105A; instruction sheet (070-5824-00).

P6107A 10X, 100 MHz, 2 m Modular Probe. Order 010-6107-13 **$117**
Includes: Same as the P6105A; instruction sheet (070-5518-00).

P6149A 10X, 50 MHz, 2 m Modular Probe **$110**
Includes: Same as the P6105A; instruction sheet (070-5510-00).

OPTIONAL ACCESSORIES
MANUALS

P6102A Order 070-5847-00 **$1**
P6105A Order 070-5231-00 **$3**
P6106A Order 070-5232-00 **$3**
P6107A Order 070-5297-00 **$3**
P6108A Order 070-5233-00 **$3**
P6149A Order 070-5247-00 **$3**

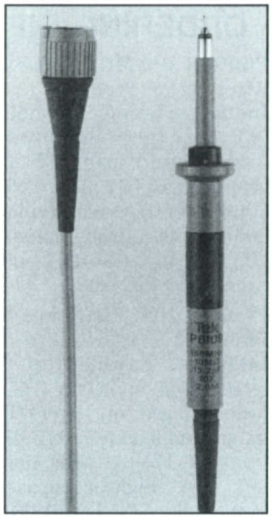
CHARACTERISTICS

	Length	Atten-uation	Loading	Bandwidth	DC Max	Scope C in pF
P6101A	1 m	1X	1 MΩ 32.0 pF	34 MHz	500 V	Any
	2 m	1X	1 MΩ 54.0 pF	15 MHz	500 V	Any
	3 m	1X	1 MΩ 78.0 pF	8 MHz	500 V	Any
P6102A	2 m	10X	10 MΩ 13.2 pF	60 MHz	500 V	36-55
P6105A	1 m	10X	10 MΩ 8.7 pF	100 MHz	500 V	15-35
	2 m	10X	10 MΩ 11.2 pF	100 MHz	500 V	15-35
	3 m	10X	10 MΩ 13.2 pF	90 MHz	500 V	15-30
P6106A	1 m	10X	10 MΩ 8.7 pF	250 MHz	500 V	15-35
	2 m	10X	10 MΩ 11.2 pF	250 MHz	500 V	15-35
	3 m	10X	10 MΩ 13.2 pF	150 MHz	500 V	15-30
P6107A	2 m	10X	10 MΩ 13.0 pF	100 MHz	500 V	20-51
P6108A	1 m	10X	10 MΩ 8.7 pF	100 MHz	500 V	15-35
	2 m	10X	10 MΩ 11.2 pF	100 MHz	500 V	15-35
	3 m	10X	10 MΩ 13.2 pF	90 MHz	500 V	15-30
P6149A	2 m	10X	10 MΩ 13.0 pF	50 MHz	500 V	20-51

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

P6103
DC to 50 MHz, 10X Modular

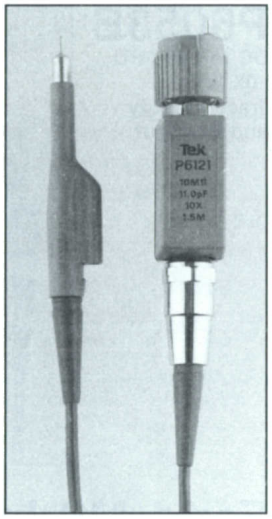
P6109
DC to 150 MHz, 10X Modular, With Readout



P6121
DC to 100 MHz, 10X Modular, With Readout

P6122
DC to 100 MHz, 10X Modular

P6125
DC to 250 MHz, 5X Modular, Counter



Ruggedized Probes For 1 MΩ Input

- **Improved, Rugged, Replaceable Tip**
- **Hybrid Circuitry for Improved Performance**
- **New, Two-Piece Modularity**

The P6103/P6109 are ruggedized modular passive voltage probes. The modular probe head houses all circuitry, including low frequency compensation. The cable assembly comes with an attached BNC connector.

Both probes feature easily replaceable screw-in probe tips. These probe tips have been specifically engineered to provide improved long-term performance and reliability. Both are compatible with the miniature size probe accessories (see probe accessories page 529).

The P6103 is included with the 2225 oscilloscope. The P6109 is included with the 2245 and 2246 GPS oscilloscopes. Oscilloscopes equipped with readout can be activated by the P6109.

For 1 MΩ Input

- **Small, Precision Tip**
- **Flexible, Low Mass Cable**
- **Hybrid Circuitry for Improved Performance**
- **UL Listed**

The P6120 probe family features modular construction, easily replaceable parts and hybrid circuitry. These probes are also fully compatible with the wide selection of miniature probe accessories.

The P6122 general purpose probe accommodates oscilloscopes with bandwidths up to 100 MHz. The P6121 with readout capability is specifically designed for the Tektronix 2236 oscilloscope to provide close tolerance readings when using the 2236 DMM functions.

The P6125 is a low capacitance, 5X attenuation passive probe specially designed for dc to 250 MHz digital counter/timers. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. It makes more accurate time interval measurements of high speed logic signals possible with minimum loading of the circuits under test.

See probe accessories, page 529.

CHARACTERISTICS

	Length	Attenuation	Loading	Bandwidth	DC Max	Scope C in pF
P6103	1 m	10X	10 MΩ 13.2 pF	50 MHz	500 V	15-35
	2 m	10X	10 MΩ 10.9 pF	50 MHz	500 V	15-35
	3 m	10X	10 MΩ 15.5 pF	50 MHz	500 V	15-35
P6109	1.5 m	10X	10 MΩ 13.2 pF	150 MHz	500 V	18-22
	2 m	10X	10 MΩ 11.6 pF	150 MHz	500 V	18-22
	3 m	10X	10 MΩ 15.5 pF	100 MHz	500 V	18-22
P6121*[1]	1.5 m	10X±2%	10 MΩ 11.0 pF	100 MHz	500 V	20-26
P6122	1.5 m	10X	10 MΩ 11.0 pF	100 MHz	500 V	15-35
	2 m	10X	10 MΩ 12.0 pF	100 MHz	500 V	15-35
	3 m	10X	10 MΩ 14.0 pF	90 MHz	500 V	15-35
P6125	1.5 m	5X	5 MΩ 20.0 pF	250 MHz	250 V	15-33

*[1] *Designed specifically for use with the 2236 to insure optimum DMM readings.*

ORDERING INFORMATION

P6103 10X, 50 MHz, 2 m Modular Probe — **$35**

Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (B3, 013-0107-05); replaceable probe tip (B27, 131-3723-00); 12 in. ground lead (196-3120-00); 2 each of white, yellow, red and green cable markers; instruction sheet (070-6156-00).

OPTIONS

Option 01—1 m cable. — **NC**
Option 03—3 m cable. — **NC**

P6109 10X, 150 MHz, 2 m Modular Probe — **$58**

Includes: Same as the P6103; instruction sheet (070-6157-00).

OPTIONS

Option 01—1.5 m cable. — **NC**
Option 03—3 m cable. — **NC**

P6122 10X, 100 MHz, 1.5 m Modular Probe — **$58**

Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (B3, 013-0107-05); probe tip ground cover (B16, 166-0404-01); 8.8 in. alligator ground lead (G10, 195-1870-00); 3.5 in. ground lead (G1, 195-6176-00); alligator clip (A16, 344-0046-00); 2 silver cable marker bands; instruction sheet (070-5511-00).

OPTIONS

Option 02—2 m cable. — **NC**
Option 03—3 m cable. — **NC**

P6121 10X, 100 MHz, 1.5 m Modular Probe — **$100**

Includes: Same as the P6122; instruction sheet (070-5512-00).

P6125 5X, 250 MHz, 1.5 m Modular Probe — **$75**

Includes: Same as the P6122; instruction sheet (070-3617-02).

OPTIONAL ACCESSORIES
MANUALS

P6121 Order 070-3739-01 — **$1.50**
P6122 Order 070-4431-01 — **$3**
P6125 Order 070-3617-02 — **$2**

For probe accessories see pages 529-530.

For replaceable subassemblies see page 531.

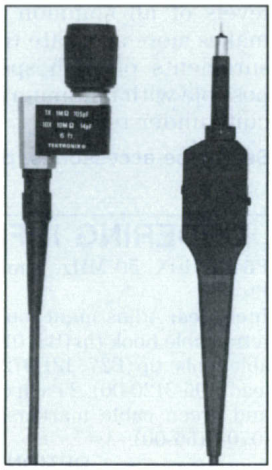
Instrument compatibility chart is on pages 508-509.

P6062B

DC to 100 MHz, 1X/10X With Readout

P6063B

DC to 200 MHz, 1X/10X With Readout



For 1 MΩ Input

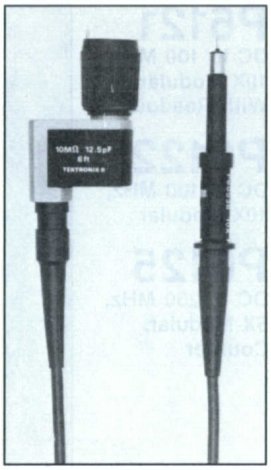
- **1X and 10X Selectable Attenuation**
- **Attenuation Switch on Probe Body**
- **Scope Readout Changes to Selected Attenuation**

The P6062B and P6063B are passive dual attenuation probes designed for oscilloscopes with bandwidths to 100 and 200 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. This 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the test instrument. Attenuation may be arbitrarily switched from 1X to 10X to evaluate the effects of loading of the oscilloscope on the circuit under test.

Both probes activate the readout coding for oscilloscopes which have readout capability. Readout changes with the probe attenuation switch so the correct attenuation setting is always displayed on the oscilloscope. A pushbutton for ground reference is standard with both probes. This provides an easy way to identify a trace in a multitrace display. Both probes are compatible with the miniature accessories.

P6053B

DC to 200 MHz, 10X With Trace Identify and Readout



For 1 MΩ Input

- **Miniature Probe Tip Size**
- **Trace Identify Button for Remote Selection of 7D20 Menus**
- **Fast Rise Time**

The P6053B is a miniature fast-rise 10X probe designed for Tek instruments having a nominal input capacitance of 15 to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability. The P6053B is compatible with all miniature probe accessories.

ORDERING INFORMATION

P6062B 100 MHz, 6 ft Switchable Attenuation Probe **$175**

Includes: Retractable hook tip (B3, 013-0107-05); probe tip ground cover (B16, 166-0404-01); 5 in. ground lead (G7, 175-0124-01); 12 in. ground lead (G7, 175-0125-01); hook tip (B6, 206-0114-00); two replaceable tips (B25, 206-0191-00); probe holder (352-0351-00); two alligator clips (A16, 344-0046-00); instrument sheet (062-2927-00).

P6053B 10X, 6 ft Trace Identify Probe **$150**

Includes: Bayonet tip (B15, 013-0085-01); retractable hook tip (B3, 013-0107-05); two probe tip ground covers (B16, 166-0404-01); 5 in. ground lead (G7, 175-0124-01); 3 in. ground lead (G7, 175-0263-01); hook tip (B6, 206-0114-00); two alligator clips (A16, 344-0046-00); probe holder (352-0351-00); two each of black, white and silver cable markers; instruction sheet (070-1594-00).

OPTIONS

Option 01—3.5 ft cable. **NC**

Option 03—9 ft cable. **NC**

P6063B 200 MHz, 6 ft Switchable Attenuation Probe **$215**

Includes: Same as P6062B except 3 in. ground lead (G7, 175-0263-01) instead of the 12 in. ground lead; instruction sheet (062-2928-01)

Option 01—3.5 ft cable. **NC**

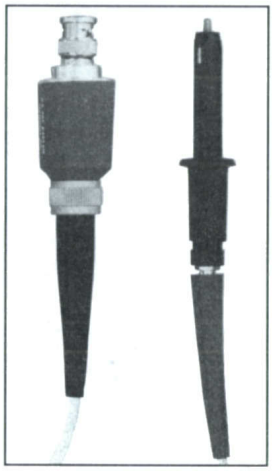
CHARACTERISTICS

	Nominal Probe Length	P6062B		P6063B		P6053B
Attenuation		1X	10X	1X	10X	10X
Accuracy		Same as Scope	3%*1	Same as Scope	3%*1	3%
Input Resistance		Same as Scope	10 MΩ*1	Same as Scope	10 MΩ*1	10 MΩ
Input Capacitance	3½ ft 6 ft 9 ft	100 pF 105 pF 135 pF	13.5 pF 14 pF 17 pF	80 pF 105 pF NA	11 pF 14 pF NA	9.5 pF 12.5 pF 13.5 pF
Bandwidth	3½ ft 6 ft 9 ft	8 MHz 6.7 MHz 4.5 MHz	100 MHz 100 MHz 100 MHz	12 MHz 6 MHz NA	200 MHz 200 MHz NA	200 MHz 200 MHz 115 MHz
Maximum DC Voltage		100 V	500 V	100 V	500 V	500 V
Derated Above		450 kHz	3.5 MHz	450 kHz	4.5 MHz	4.2 MHz
Derated to Frequency		35 V @ 10 MHz	35 V @ 50 MHz	35 V @ 10 MHz	30 V @ 50 MHz	
Aberrations		±3%	<5% p-p	±3%	<5% p-p	
Rise Time			3.5 ns		1.7 ns	
Scope C in pF		15 to 47 pF		15 to 24 pF		15 to 24 pF

*1 *In 10X position the input R=10 MΩ ±0.5% with an oscilloscope input R=1 MΩ ±2%.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

P6008
100 MHz, 10X
Environmental



For 1 MΩ Input

- **−50 to +150°C Temperature Range**

The P6008 Environmental Probe operates over −50 to +150 °C for the probe body and cable; the compensation box operates from −15 to +55 °C. It is designed for use with dc to 100 MHz oscilloscopes. The probe can be compensated to match plug-ins and oscilloscopes with nominal input capacitance of 12 to 47 pF and input resistance at 1 MΩ. The P6008 is compatable with the screw-tip accessories.

CHARACTERISTICS

	P6008
Attenuation	10X
Input Resistance	10 MΩ
Input Capacitance	≈7.5 pF with an instrument having 20 pF input capacitance
Bandwidth	DC to 100 MHz
Voltage Rating	600 V dc, ac peak, or dc and ac peak combined. P-p voltage derating is necessary for cw frequencies>20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V
Cable Length	1.8 m (6 ft)
Scope C in pF	12-47

ORDERING INFORMATION

P6008 10X, 6 ft Environmental Probe **$250**

Includes: Retractable hook tip (A2, 013-0071-01); banana tip (A12, 134-0013-00); 12 in. ground lead (G7, 175-0125-01); alligator clip (A15, 344-0045-00); probe holder (352-0090-00); instruction sheet (070-1173-00).

Option 01—3.5 ft cable, nonenvironmental **−$10**

P6048
DC to 100 MHz,
10X

For 1 MΩ Input

- **Minimum Loading, 1 pF at 1 kΩ**
- **AC/DC Switch**

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF oscilloscopes. The probe input impedance of 1 kΩ paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. AC or dc coupling switch is available to extend the measurement range.

CHARACTERISTICS

	P6048
Attenuation	10X
Input Resistance	1 kΩ
Input Capacitance	1 pF or less
Maximum Input	DC 20 V; ac 200 V
AC Low Frequency	7 kHz or less
Bandwidth	100 MHz with 150 MHz bandwidth scope; 175 MHz with 250 MHz bandwidth scope
Typical Probe Rise Time	1.95 ns
Scope C in pF	15-20

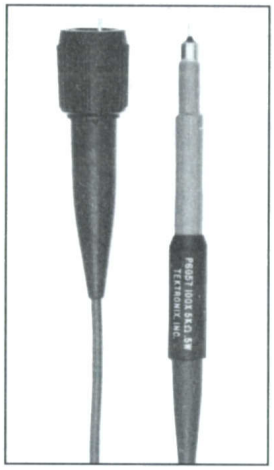
ORDERING INFORMATION

P6048 10X, 6 ft Minimum Loading Probe **$220**

Includes: Retractable hook tip (E1, 013-0090-00); 2 probe tip ground covers (B16, 166-0404-01); insulating sleeves (D8, 166-0433-00); 5 in. ground lead (G7, 175-0124-01); 3 in. ground lead (175-0263-01); hook tip (G7, 206-0114-00); 2 miniature alligator clips (A16, 344-0046-00); probe holder (352-0090-00); instruction manual (070-0675-01).

P6056
DC to 3.5 GHz,
10X 500 Ω
With Readout

P6057
DC to 1.4 GHz,
100X 5000 Ω
With Readout



For 50 Ω Input

- **Minimum Loading, 1 pF or Less**
- **<70 ps Probe to Probe Variation**

The P6056 and P6057 are miniature low-capacitance probes for use with 50 Ω wide-band oscilloscopes. Both have BNC connector that provides trace identification and CRT readout information when used with instruments having these features. A convenient button on the probe activates this function. These probes can also be used with 50 Ω sampling systems, with an appropriate BNC adapter.

CHARACTERISTICS

	P6056	P6057
Rise Time	<100 ps	<250 ps
Input R @ DC	500 Ω	5 kΩ
Input R @ 1 GHz	300 Ω	1500 Ω
Maximum DC + Peak AC	16 V	50 V
Derated Above	800 MHz	500 MHz
Maximum Peak @ 1 GHz	9 V	21 V
Maximum Peak Pulse	500 V <1 ms	500 V <1 ms

ORDERING INFORMATION

P6056 10X, 6 ft 50 Ω Probe **$200**

Includes: 6 in. ground lead (G6, 175-0849-01); 3 in. ground lead (G1, 195-6176-00); replaceable tip (013-0085-00); hook tip (206-0114-00); 2 electrical contacts (B28, 214-0283-00); alligator clip (344-0046-00); instruction sheet (070-1224-00).

Option 3—9 ft cable **NC**

P6057 100X, 6 ft 50 Ω Probe **$195**

Includes: Same as P6056 except replaceable tip (307-0329-01).

Option 03—9 ft cable. **NC**

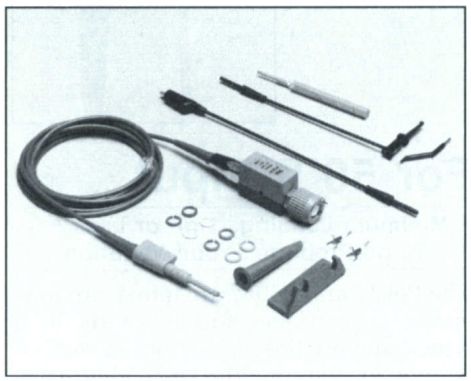
10X Modular with Readout

P6130
DC to 250 MHz

P6131
DC to 300 MHz

P6133
DC to 150 MHz

P6136
DC to 350 MHz

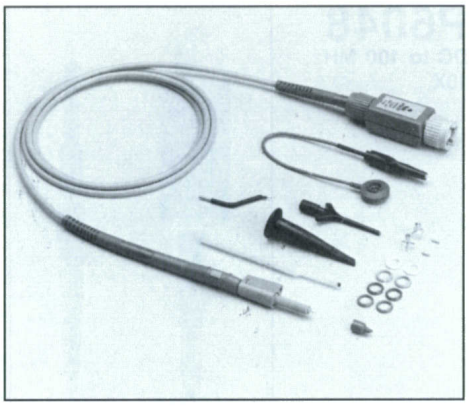


For 1 MΩ Input

- **Subminiature Tip for Precise Probing**
- **Flexible Lightweight Cable**
- **Modular for Low Cost of Ownership**
- **Hybrid Circuitry Performance**
- **UL Listed**

The P6130 subminiature probe family features modular construction, hybrid circuitry and a subminiature probe tip which can easily negotiate dense circuitry or tight spaces. Each probe has 10X attenuation and activates the readout-encoding circuit of oscilloscopes with the feature.

These probes are compatible with the subminiature probe accessories. Full compatibility with the miniature accessories



P6136 shown with typical accessories.

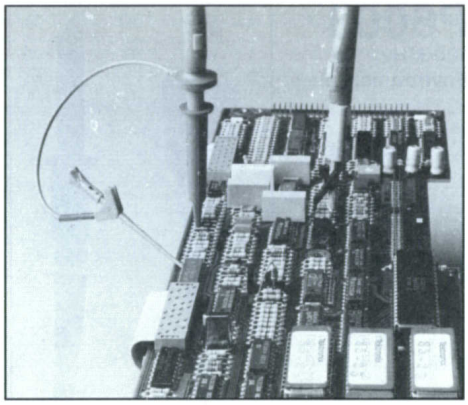
is available when the subminiature-to-miniature probe tip adapter (013-0202-02) is installed over the probe tip. The P6130 general purpose probe can be used with instruments with bandwidths up to 250 MHz. The P6131 is specially designed for the Tektronix 7A42 and older 2465 oscilloscopes. The P6133 is for use with the 2445A. The P6136 and P6137 are specially designed for the 2455A, 2465A, and 2467.

ENVIRONMENTAL

Temperature Range—Operating: −15 to +75 °C. Nonoperating: −62 to +85 °C.
Humidity—Five cycles (120 hrs) 95 to 97% at +30 to +60 °C. MIL-E-16400F, Class 4.
Altitude—Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

ORDERING INFORMATION

P6130 10X, 250 MHz, 2 m Subminiature Probe **$130**
Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (C1, 013-0208-01); circuit board connector (C5, 131-2766-03); 8.8 in. alligator ground lead (G10, 195-1870-00); 6 in. microhook ground lead (G5, 195-4104-00); 2 in. ground lead (G9, 195-4240-00); probe holder (352-0687-00); each of white, gray, red and green cable markers; instruction sheet (070-5513-00).



Probe Accessories shown in use on a circuit board. A circuit board connector (131-2766-03) is used to connect the probe to the test point for minimal signal distortion and maximum measurement convenience. Other connectors and adapters are available.

OPTIONS

Option 01—1.5 m cable. **NC**
Option 03—3 m cable. **NC**

P6131 10X, 300 MHz, 1.5 m Modular Probe **$140**
Includes: Same as the P6130; instruction sheet (070-5514-00).

OPTIONS

Option 02—2 m cable. **NC**
Option 03—3 m cable. **NC**

P6133 10X, 150 MHz, 2 m Modular Probe **$115**
Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (C1, 013-0208-01); 8.8 in. alligator ground lead (G10, 195-1870-00); 6 in. microhook ground lead (G5, 195-4104-00); instruction sheet (070-5795-00).

OPTIONS

Option 01—1.3 m cable. **NC**
Option 03—3 m cable. **NC**

P6136 10X, 350 MHz, 1.3 m Modular Probe **$150**
Includes: Same as the P6130; instruction sheet (070-6025-00).

OPTIONAL ACCESSORIES
MANUALS

P6130—Order 070-4160-01 **$1.50**
P6131—Order 070-4210-01 **$3**
P6133—Order 070-5839-00 **$1**
P6136—Order 070-6026-00 **$1**
KLIPKIT—Order 013-0197-00 **$46**
Includes: Two clips and four pins.
Extra pins—Packet of four. Order 131-3288-02 **$29**

For probe accessories see pages 529-530.
For replaceable subassemblies see page 531.

CHARACTERISTICS

	Probe Length	P6130	P6131	P6133	P6136
Attenuation		10X ±3%	10X ±1%	10X ±1%	10X ±1%
Loading	1.3 m	—	10 MΩ 10.8 pF	10 MΩ 10.8 pF	10 MΩ 10.8 pF
	1.5 m	10 MΩ 12.7 pF	—	—	—
	2.0 m	10 MΩ 13.2 pF	10 MΩ 13.5 pF	10 MΩ 13.5 pF	—
	3.0 m	10 MΩ 14.5 pF	10 MΩ 14.5 pF	—	—
Bandwidth	1.3 m	—	300 MHz	150 MHz	350 MHz
	1.5 m	250 MHz	—	—	—
	2.0 m	250 MHz	—	150 MHz	—
	3.0 m	150 MHz	150 MHz	120 MHz	—
Dc Max		500 V	500 V	500 V	500 V
Scope		2235, 2236, 464, 465, 466, 475, 485, 7A15, 7A16, 7A18, and 7A26 (1 MΩ input)	2465A, 7A42 (1 MΩ input)	2445A	2455A, 2465A, and 2467

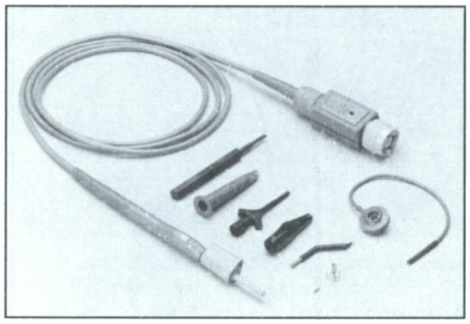
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

P6134

DC to 300 MHz, 10X,
Passive Probe, With Identify and Readout

P6135 DC to 150 MHz, 10X,

Passive Differential Probe,
With Identify and Readout



P6134 shown with typical accessories.

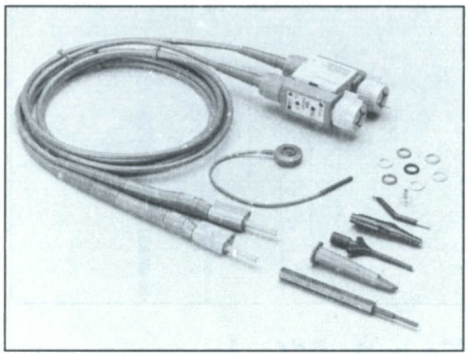
For Use With the "Intelligent" TekProbe Interface of the 11000 Series Plug-Ins

- **Identify Button on Each Probe Allows Remote Sequencing of Oscilloscope Programs**
- **Automatic Input Impedance Selection**
- **Activates Readout on 11000 Series Oscilloscopes**
- **Probe Power Comes Through Connector—No Extra Power Supply or Cables Needed**
- **Uses Subminiature Probe Accessories**

The P6134, P6135 and P6231 probes are the first in a line of "intelligent" probes. Through the TekProbe interface connector, the probe can (if available on the specific probe) communicate one or more of the following: its type, serial number, attenuation, input impedance, offset scale factor, and other key parameters to and from the host instrument. Power for compatible probes is also supplied through the TekProbe interface, eliminating the need for extra cabling and external power supplies. The probe connectors allow easy and positive locking to the test instrument.

An "ID" button is standard with each probe which, when pressed, causes one of several programmable actions to be taken by the mainframe (e.g., autoset, setup recall, automatic measure, SRQ, etc.).

The P6134 and P6135 are passive probes designed for amplifiers with an input impedance of 1 MΩ. The P6135 comes as a pair of differential probes which can be matched for high CMRR when used with the 11A33 Differential Comparator plug-in.



P6135 differential probe shown with typical accessories

CHARACTERISTICS

	P6134	P6135
Attenuation	10X ±1%	10X Adjustable ±3%
Input R	9 MΩ ±0.3%	1 MΩ ±0.32% at dc
Input C	11.3 pF	10.8 pF
Bandwidth	300 MHz	150 MHz
Rise Time		
Input Voltage	500 V (dc + peak ac)	500 V (dc + peak ac)
CMRR	NA	10000:1 dc to 1 kHz derating to 100:1 at 20 MHz

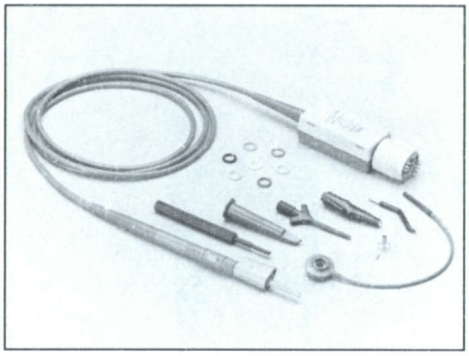
ORDERING INFORMATION

P6134 10X, 300 MHz, 1.5 m Passive Probe **$170**
Includes: Adjustment tool (F3, 003-1364-01), retractable hook tip (C1, 013-0208-01), two circuit board connectors (C5, 131-2766-03). 2 in. ground lead (G9, 195-4240-00), 6 inch ground lead (196-3113-00), Miniature alligator clip (A16, 344-0046-00), IC grabber (013-0217-00); two each of black, white, silver, gray, blue, orange, red, green and yellow cable markers; instruction manual (070-6029-00).
P6135 Pair of 10X, 150 MHz, 1.5 m Differential Probes*[1]
Includes: Same as the P6134 for each probe; instruction manual (070-6158-00).

*[1] *Contact your local Sales Office.*

P6231

DC to 1.5 GHz, 10X,
Bias/Offset Probe, With Identify and Readout



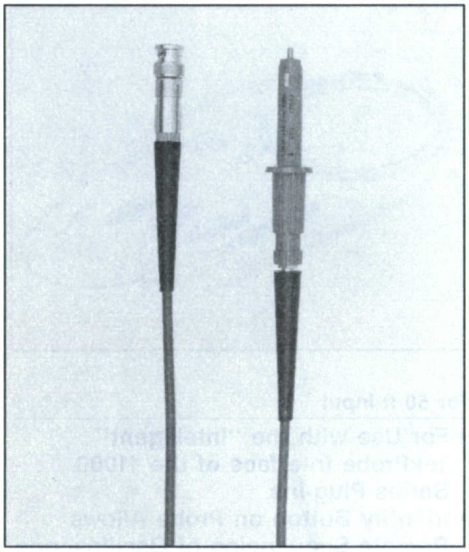
For 50 Ω Input

- **For Use with the "Intelligent" TekProbe Interface of the 11000 Series Plug-ins**
- **Identify Button on Probe Allows Remote Sequencing of Oscilloscope Programs**
- **Probe Power Comes Through Connector**
- **Bias/Offset for Adjusting Tip "Nulling" Voltage (± 5.0 V DC)**

Refer to Active probes on page 520 for specifications and Ordering Information.

P6007

DC to 25 MHz, 100X



For 1 MΩ Inputs

- **1500 V DC**
- **Low Capacitance Loading**

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all plug-ins and oscilloscopes with nominal input capacitances of 15 to 55 pF and input resistance of 1 MΩ.

ORDERING INFORMATION

P6007 100X, 6 ft High Voltage Probe **$130**

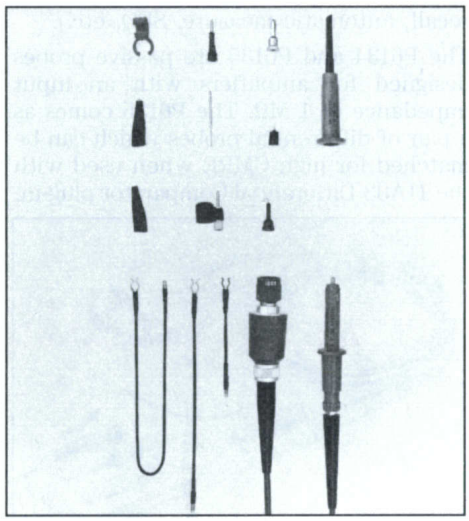
Includes: Retractable hook tip (A1, 013-0071-00); banana tip (A12, 134 0013-00); 5 in. ground lead (G7, 175-0124-01); 12 in. ground lead (G7, 175-0125-01); 0.055 in. diameter straight tip (206-0015-00); 0.080 in. diameter spring tip (A4, 206-0060-00); hook tip (A6, 206-0105-00); two miniature alligator clips (A16, 344-0046-00); probe holder (352-0090-00); instruction manual (070 0388-01).

OPTIONS

Option 01—3.5 ft cable. **NC**
Option 03—9 ft cable. **NC**
Option 04—12 ft cable. **NC**

P6009

DC to 120 MHz, 100X With Readout



For 1 MΩ Inputs

- **1500 V DC**
- **DC to 120 MHz**
- **Low Capacitance—2.5 pF**

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with dc to 150 MHz oscilloscopes. The probe can be compensated to match plug-ins and oscilloscopes with nominal input capacitances of 12 to 47 pF and input resistance of 1 MΩ.

The P6009 is equipped with a special BNC connector that provides CRT Readout information when used with plug-in units and mainframes that have these features.

ORDERING INFORMATION

P6009 100X, 9 ft High Voltage Probe With Readout **$205**

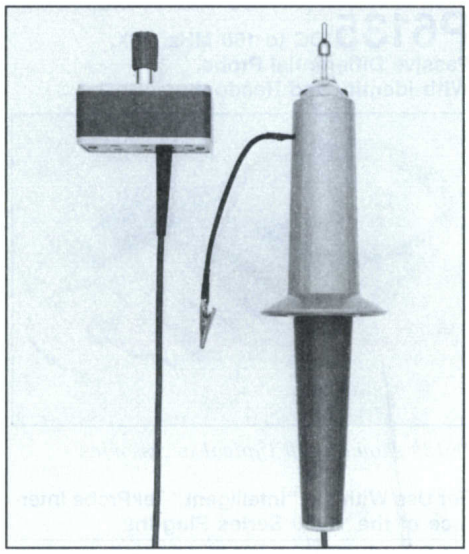
Includes: Same as the P6007 plus bayonet ground assembly (A17, 013-0052 00); 3 in. ground lead (G7, 175-0263-01); instruction manual (070-0401 01).

OPTION

Option 14—9 ft without Readout. **NC**

P6015

40 kV, Peak Pulse, 1000X



For 1 MΩ Inputs

- **Measure up to 40 kV Peak Pulse**
- **Up to 20 kV DC + Peak AC**
- **75 MHz Useful Bandwidth**

The P6015 Provides 1000X attenuation for oscilloscope measurements up to 40 kV peak pulse. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or at temperatures above 25 °C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF and input resistance of 1 MΩ.

ORDERING INFORMATION

P6015 1000X, 10 ft High Voltage Probe **$725**

Includes: Carrying case (016-0128-02); high-voltage dielectric fluid (A21, 252-0120-00); alligator clip (A14, 344-0005-00); probe holder (352-0056-00); instruction manual (070-0373-02).

OPTIONS

Option 10—Without freon. Max 13 kV. **NC**
Option 25—25 ft cable. **+$100**
Option 26—25 ft cable without freon. Max 13 kV. **$100**

CHARACTERISTICS

	Attenuation	Accuracy	Input Resistance	Input Capacitance 3½ ft	6 ft	9 ft	Probe Rise Time	Aberrations	Bandwidth	Nominal Cable Length (ft)	Maximum DC or RMS Voltage	Derated Above	Scope C in pF
P6007	100X	3%	10 MΩ	2 pF	2.2 pF	2.4 pF	14.0 ns	±3	25 MHz	3½, 6, 9, 12	1.5 kV	200 kHz	15 to 55
P6009	100X	3%	10 MΩ			2.5 pF	2.9 ns	±3	120 MHz	9	1.5 kV	200 kHz	15 to 47
P6015	1000X	Adjustable	100 MΩ	3 pF (10 ft only)			4.0 ns	±5	75 MHz	10	20.0 kV	100 kHz	12 to 47

Above probes compatible with screw-tip accessories. Instrument compatibility chart is on pages 508-509.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

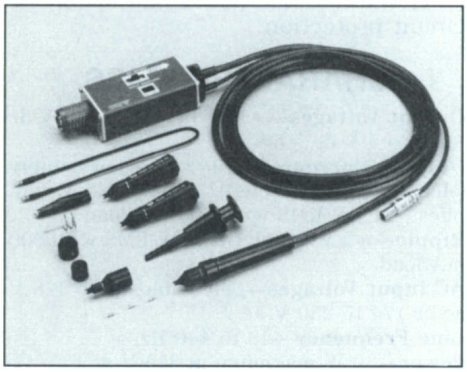
ACTIVE PROBES

Active probes have high input resistance and low input capacitance without loss of signal. The dynamic range and measurement capability are substantially increased through the voltage offset control.

Since active probes have a selectable 50 Ω output impedance, the distance from the probe tip to the instrument is only limited by the bandwidth limit of the 50 Ω coaxial cables between the probe and instrument. Active probes are used in measurements where high input resistance and low input capacitance is needed and frequencies above 250 MHz are encountered.

P6201

DC to 900 MHz, 1X With Readout
Typically 1.1 GHz*



For 50 Ω or 1 MΩ Inputs

- **Unity Gain, Low Input Capacitance**
- **Two Plug-on Attenuator Heads That Maintain Scope Readout Factor**
- **Dc Offset, AC-DC Coupling Switch**

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance. The probe derives its power from the probe power jack on many Tek scopes, or an 1101A Power Supply.

* *At room temperature.*

ACTIVE PROBE SELECTION GUIDE

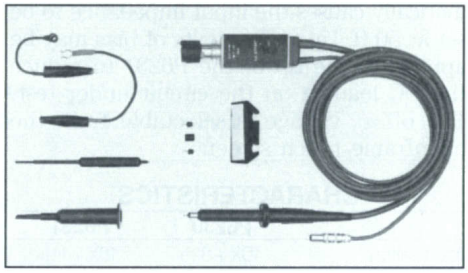
Type	Attn	Nominal Length	Loading		Rise Time	Input Limits: Maximum Dc + Pk Ac	Input Limits: Linear Dynamic Range	Input Limits: Dc Offset Range	Read-Out	Price
P6201 FET	1X 10X 100X	6 ft	100 kΩ 1 MΩ 1 MΩ	3 pF 1.5 pF 1.5 pF	0.4 ns	±100 V ±200 V ±200 V	±0.6 V ±6 V ±60 V	±5.6 V ±56 V ±200 V	Yes	$1,250
P6202A FET	10X 100X	2 m	10 MΩ 10 MΩ	2 pF 2 pF	0.7 ns 0.7 ns	±200 V ±200 V	±6 V ±60 V	±55 V ±200 V	Yes No	$715
P6230 Bias/Offset	10X	1.6 m	450Ω	1.3 pF	230 ps	±30 V	±5 V	±5 V	Yes	$420
P6231 Bias/Offset	10X	1.5 m	450Ω	1.6 pF	230 ps	±30 V	±10 V	±5 V	Yes	$410

ORDERING INFORMATION

P6201 1X, 6 ft FET Probe **$1,250**
Includes: Retractable probe tip (D1, 013-0135-00); 10X attenuator head (010-0376-00); 100X attenuator head (010-0377-00); 3 probe tips (D9, 206-0200-00); probe tip (D2, 103-0164-00); 30 cm (12 in.) ground lead (G4, 175-0848-02); ground contact (D5, 131-1302-00); alligator clip (A16, 344-0046-00); electrical insulating sleeve (D6, 166-0557-00); ground contact insulator (D7, 342-0180-00); carrying case; instruction manual (070-1306-00).

P6202A

DC to 500 MHz, 10X With Readout



For 50 Ω or 1 MΩ Inputs

- **DC Offset, Small Probe Size**
- **High Input Impedance Through Freq Range**

The low input capacitance of the P6202A permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading. The dc offset feature offsets any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The P6202A derives its power from the probe power jack on many Tek scopes, or an 1101A Power Supply.

CHARACTERISTICS

	P6201	P6202A
Rise Time	<0.4 ns	<0.7 ns
Bandwidth*1	>900 MHz *3	>500 MHz
Attenuation	×1	×10
Attenuation Accuracy	±3%	±4%
Input Resistance	100 kΩ	10 MΩ
Input Capacitance	3 pF	2 pF
Input R with Attenuator	1 MΩ	10 MΩ*2
Input C with Attenuator	1.5 pF	2 pF*2
Dynamic Range	±0.6 V	±6.0 V
Dynamic Range with Attenuator	±6 V or ±60 V	±60 V*2
DC Offset Range	±5.6 V	±55 V
Noise	300 μV	150 μV
Maximum Input Probe Only	±100 V peak	±200 V peak
Derated above	60 MHz	2 MHz
Derated to— at Frequency	5 V at 500 MHz	20 V at 300 MHz
Maximum Input with Attenuator	200 V peak	200 V peak*2
Derated above	50 MHz	150 MHz*2
Derate to— at Frequency	5 V at 500 MHz	70 V at 400 MHz*2
AC Coupling −3 dB Low Frequency	10 Hz	16 Hz

*1 *Verified by rise time.*
*2 *Optional accessory.*
*3 *Typically 1.1 GHz at room temperature.*

ORDERING INFORMATION

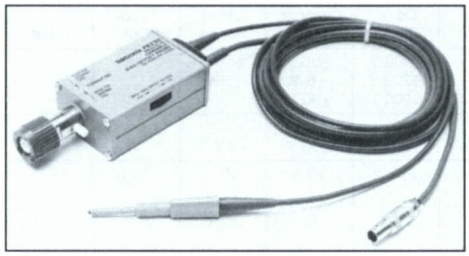
P6202A 10X, 2 m FET Probe **$715**
Includes: Retractable probe tip (E2, 013-009701); 2 alligator clips (A16, 344-0046-00); probe holder (352-0351-00); 7.5 cm (3 in.) ground (G6, 175-0849-00); probe adjustment tool (F5, 003-0675-01); carrying case; 13 cm (6 in.) ground lead (G8, 175-1017-00); 2 replaceable probe tips*1; electrical insulating sleeve (B16, 166-0404-01); instruction manual (070-3642-00).
*1 *Available in package of 10 only. Order 206-0230-03 (B26).*

P6202A OPTIONAL ACCESSORIES

10X Attenuator—For total 100X attenuation. Order 010-0384-00 **$75**
AC Coupling Cap—Order 010-0360-00 **$38**

P6230

DC to 1.5 GHz, 10X Bias/Offset With Readout



For 50 Ω or 1 MΩ Inputs

- **Bias/Offset**
- **Internal/External 50 Ω Termination Switch**
- **Low Impedance**
- **For Adjusting Tip "Nulling" Voltage (±5.0 V DC)**
- **Fully Compatible With Tek Subminiature Probe Accessories**
- **UL Listed**

The P6230 is a 1.5 GHz, low-impedance, subminiature, 10X active probe for use with broad-band scopes. A switch on the compensation box allows selection of internal or external 50 Ω termination so the probe may be used with instruments having either 50 Ω or 1 MΩ input resistances. A coding pin on the BNC connector activates the readout of instruments with this feature.

The P6230 acts as a standard 500 Ω passive voltage probe with the additional capability of having an adjustable tip "nulling voltage." This feature reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage value is not at zero volts, or in circuits where the termination impedance is not returned to ground level. The Input Bias/Offset Voltage may be adjusted so that the voltage at the probe input resistor is equal to the test signal potential; thus, no current flows through the input resistor.

The probe derives its power from the probe power jack on many Tek scopes or the 1101A Power Supply.

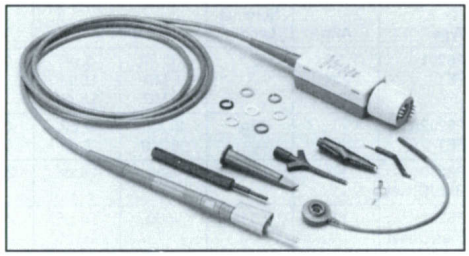
The P6230 is compatible with all subminiature probe accessories. With the subminiature-to-miniature probe tip adapter (013-0202-02), all miniature probe accessories on page 529 can be used.

ORDERING INFORMATION

P6230 10X, 1.5 in. Bias/Offset Probe **$420**
Includes: Adjustment tool (F3, 003-1364-01), retractable hook tip (C1, 013-0208-00), circuit board connector (C5, 131-2766-03), 8.8 in. alligator ground lead (G10, 195-1870-00), 6 in. microhook ground lead (G5, 195-4104-00), 2 in. ground lead (G9, 195-4240-00), probe holder (352-0687-00); 2 each of white, gray, red and green cable markers; manual (070-4211-00).

P6231

DC to 1.5 GHz, 10X, Bias/Offset Probe, With Identify and Readout



For 50 Ω Input

- **For Use with the "Intelligent" TekProbe Interface of the 11000 Series Plug-ins**
- **Identify Button on Probe Allows Remote Sequencing of Oscilloscope Programs**
- **Probe Power Comes Through Connector**
- **Bias/Offset for Adjusting Tip "Nulling" Voltage (± 5.0 V Dc)**

The P6231 is an active probe designed for amplifiers with an input impedance of 50 Ω, primarily the 11A52 and 11A71 high-frequency amplifiers. Connection of the P6231 into any other 11000 Series amplifier automatically causes the input impedance to be set at 50 Ω. Up to five volts of bias may be applied to the tip of the P6231 to reduce the DC loading on the circuit under test. The offset voltage is selectable from the mainframe touch screen.

CHARACTERISTICS

	P6230	P6231
Attenuation	10X±3%	10X±1%
Input R/C	450 Ω 1.3 pF	450 Ω 1.6 pF
Bandwidth	1.5 GHz	1.5 GHz
Max DC Input Voltage	10 V	10 V
DC Offset Range	±5.0 V	±5.0 V

ORDERING INFORMATION

P6231 10X, Bias/Offset Probe **$410**
Includes: Adjustment tool (F3, 003-1364-01), retractable hook tip (C1, 013-0208-00), 2 circuit board connectors (C5, 131-2766-03), 8.8 in. alligator ground lead (G10, 195-1870-00), 6 in. ground lead (196-3113-00), 2 in. ground lead (G9, 195-4240-00), miniature alligator clip (A16, 344-0046-00); IC grabber (013-0217-00); 2 each of white, black, silver, gray, blue, orange, red, green and yellow cable markers; manual (070-6027-00).

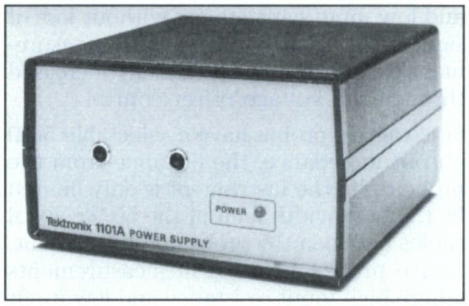
OPTIONAL ACCESSORIES

KLIPKIT—16 pin DIP package accepts the P6230 and P6130 family probes directly. Other probes must use the supplied pins and attach via a retractable hook tip. Included are two DIP clips, and four signal/ground pins. Order 013-0197-00 **$40**

KLIPKIT Signal/Ground Pins—Includes eight signal/ground pins for use with the KLIPKIT. Order 131-3288-02 **$29**

1101A

Power Supply



The 1101A Accessory Power Supply provides power for active probes such as the Tektronix P6201, P6202A and P6230 when they are used with oscilloscopes that do not supply probe power.

The 1101A will provide power for up to two probes. Output power features short-circuit protection.

CHARACTERISTICS

Output Voltages—+15 V dc ±2%; −15 V dc ±2%; +5 V dc ±5%.
Output Currents—300 mA each supply (short-circuit protected). +15 V, −15 V supplies: ≤1 mV RMS with 300 mA load.
Ripple—+5 V Supply: ≤5 mV RMS with 300 mA load.
AC Input Voltages—Selectable, 87 to 128 V ac or 174 to 250 V ac.
Line Frequency—48 to 440 Hz.
Power—30 W maximum at 115 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	157	6.2
Height	89	3.5
Depth	165	6.5
Weight ≈	**kg**	**lb**
Net	1.7	3.8

ORDERING INFORMATION

1101A Accessory Power Supply **$435**
Includes: Instruction sheet 070-5126-00.

INTERNATIONAL POWER PLUG OPTIONS
Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A4—North American 240 V, 60 Hz.
Option A5—Switzerland 220 V, 50 Hz.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

DIFFERENTIAL PROBES

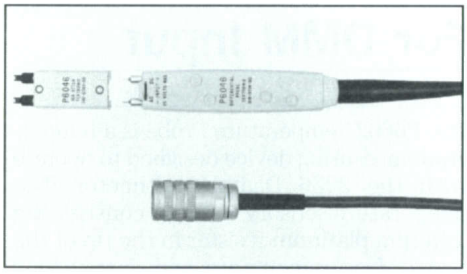
Tek supports four modes of differential measurements: the differential amplifier probe, the matched pair of probes, the isolation amplifier, and the ground interrupt monitor.

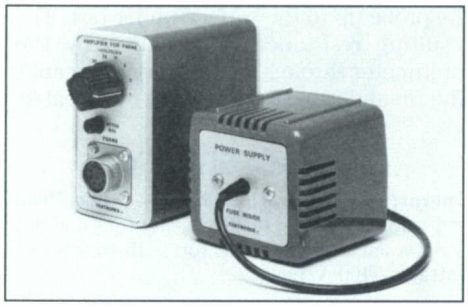
The P6046 is a 100 MHz differential amplifier in probe form. It connects into one channel of a standard scope amplifier.

A matched pair of P6055 probes can produce CMRR ratios up to 20,000:1 with differential amplifiers. A single 10X probe has accuracy of 1% or less giving a scope-to-probe CMRR of no better than 50:1.

P6046

DC to 100 MHz, 1X Differential





For 50 Ω or 1 MΩ Inputs

- **1000:1 CMRR at 50 MHz**
- **±250 V Maximum Voltage With 10X Attenuator**
- **Dual Probe Tips for Greater CMRR at High Frequencies**

The P6046 Differential Probe and P6046 Amplifier Unit provide unique measurement capabilities with all Tektronix oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

CHARACTERISTICS

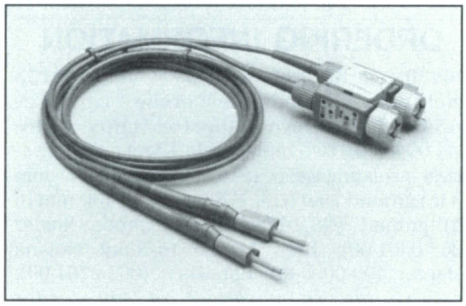
CMRR—With deflection factors of 1 to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz.
Common-Mode Linear Dynamic Range—±5 V, ±50 V with 10X attenuator.
Bandwidth—DC to 100 MHz (−3 dB).
Rise Time—3.5 ns or less.
Deflection Factor Range—1 to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div).
Input RC—1 MΩ paralleled by 10 pF or less.
Input Coupling—AC or dc, selected by a switch on the probe. Low frequency response ac-coupled is −3 dB at 20 Hz, 2 Hz with 10X attenuator.
Displayed Noise—280 μV or less (tangentially measured).
Maximum Input Voltage—±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency. The P6046 circuitry can be damaged by electrostatic discharge. Please refer to manual for use.
Output Impedance—50 Ω through a BNC-connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems.
Probe Cable—6 ft long, terminated with special nine-pin connector.

ORDERING INFORMATION

P6046 1X, 6 ft FET Differential Probe With Amplifier and Power Supply **$1,840**
Includes: 50 Ω termination (011-0049-01); amp and power supply (015-0106-00); 50 Ω coaxial cable (012-0076-00); hanger assembly (014-0029-00); carrying case (016-0111 01); 10X attenuator (010-0361-00); dual attenuator head (010-0419-00); swivel probe tip; spring ground contact; connector test point jack; instruction manual (070-0756-00).

OPTION

Option 11—Probe without amplifier and Power Supply **−$825**
Power Supply With Amplifier—Order 015-0106-00 **$1,000**



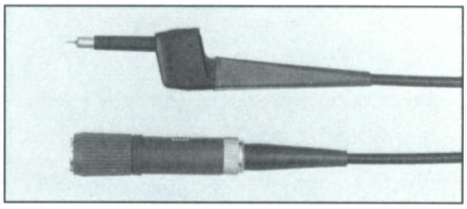
P6135 Differential Probe

Refer to the P6135 Differential Probe (pages 242 and 517) which was designed for the 11000 Series differential amplifiers.

The A6902B also provides differential capabilities. See page 528.

P6055

20,000:1 CMRR, 10X With Readout



- **High CMRR**
- **Compact Size**
- **Low Capacitance**
- **DC to 60 MHz**

The P6055 is a miniature, low capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ±2%). A special locking type readout connector allows use with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provides the best possible system CMRR.

CHARACTERISTICS

CMRR—20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.
Attenuation—Adjustable to 10X.
Input Resistance—1 MΩ ±0.5%.
Input Capacitance—≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.
Maximum Useful Bandwidth—60 MHz.
Typical Probe Rise Time—5.8 ns.
Maximum Voltage—500 V (dc + peak ac) from dc to 12 MHz, p-p V derated to 100 V at 70 MHz.

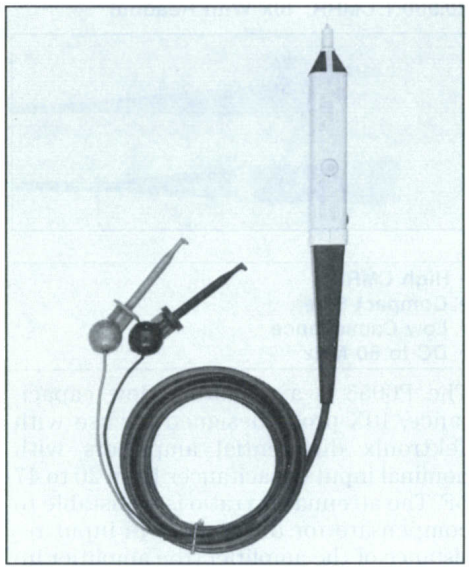
ORDERING INFORMATION

P6055 Matched Pair of 10X, 3.5 ft Differential Probes **$540**
Includes (for each probe): Probe holder (352-0090-00); adjustment tool (F4, 003-0675-00); retractable hook tip (B3, 013-0107-05); two minialligator clips (A16, 344-0046-00); probe tip ground cover (B16, 166-0404-01); 5 in ground lead (G7, 175-0124-01); 12 in ground lead (G7, 175-0125-01); 5 in ground lead (G2, 175-1256-00); hook tip (B6, 206-0114-00); instruction manual (070-1115-00).

OPTION

Option 01—Single probe with accessories **−$260**

P6401 Logic Probe



- **Illuminated Probe Tip Indicates Logic Level**

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5-V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

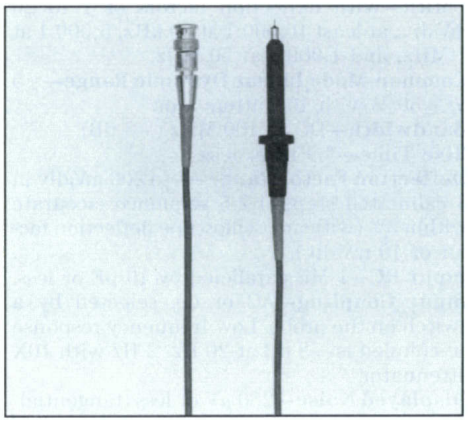
CHARACTERISTICS

Low State Input Voltage Threshold—+0.7 V ±0.125 V.
High State Input Voltage Threshold—2.175 V ±0.125 V to V cc.
Minimum Recognizable Pulse Width—10 ns.
Minimum Recognizable Strobe Pulse Width—20 ns.
Impedance—≈7.5 kΩ paralleled by ≈6 pF.
Minimum Circuit Resistance for Open Circuit Indication—10 kΩ.
Maximum Nondestructive Strobe Input—±30 V (dc or RMS).
Maximum Nondestructive Input—±150 V (dc or RMS).
Strobe Input Impedance—5.6 kΩ within 20%.

ORDERING INFORMATION

P6401 1.5 m Logic Probe **$180**
Includes: Probe tip hook (B6, 206-0114-00); strobe lead (175-0958-01); strobe lead (175-0958-00); probe tip to 0.025 inch square pin adapter (A10, 206-0137-01); white plug (348-0023-00); two alligator clips (A16, 344-0046-00); accessory pouch (016-0537-00); data sheet (062-1693-00).

P6420 RF Probe



For 10 MΩ Inputs

- **10 kHz to 1 GHz Bandwidth**
- **DC V Output/RMS of Sine Input**

The P6420 RF probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the RMS value of a sine-wave input compatible with any DMM with an input resistance of 10 MΩ.

CHARACTERISTICS

Voltage Range—0.5 to 25 V RMS (70.7 V p-p).
AC to DC Transfer Ratio Accuracy—0.5 to 5 V RMS ±10% (+15 to +35°C). 5.0 to 25 V RMS ±5% (+15 to +35°C).
Frequency Response—100 kHz to 300 MHz (±0.5 dB). 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).
Input Capacitance—≈3.7 pF.
Maximum Input Voltage—42.4 V (peak ac +dc).
Temperature Range—Nonoperating: −55 to +75°C. Operating: +15 to +35°C.
Length—Probe only: 96 mm. Cable Only: 2 m.

ORDERING INFORMATION

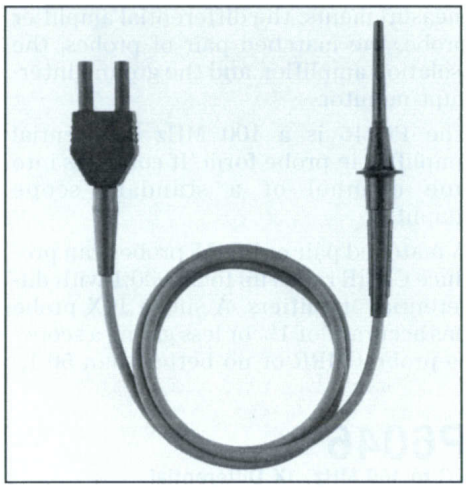
P6420 2 m RF Probe **$155**
Includes: Retractable probe tip (E2, 013-0097-01); two alligator clips (A16, 344-0046-00); two replaceable*[1] probe tips; electrical insulating sleeve (B16, 166-0404-01); 75 mm (3 in) ground lead (G6, 175-0849-00); 130 mm (6 in) ground (G8, 175-1017-00); probe holder (352-0351-00); BNC female to dual banana adapter (103-0090-00); data sheet (062-2764-00).
*[1] *Available in packages of ten (order 206-0230-03) or 100 (order 206-0230-04) (B26).*

OPTIONAL ACCESSORIES

Probe Cables—For P6420 (does not change electrical specifications):

(1 m) Order 174-0975-00	**$17**
(2 m) Order 174-0976-00	**$17.75**
(3 m) Order 174-0977-00	**$21.00**

P6602 Temperature Probe



For DMM Input

- **UL Listed**

The P6602 Temperature Probe is a temperature measuring device designed to operate with the 2236 Digital Multimeter. The temperature sensory element consists of a thin-film platinum resistor in the tip of the probe. Measurements are made by touching the probe tip to the surface under test. The resulting resistance is measured by the multimeter through a two-conductor cable. The tip and cable assembly are replaceable.

CHARACTERISTICS

Operating Temperature Range—Probe Head and Cable: −62 to +230°C (−80 to +446°F). Banana Jack Style Connector: −15 to +85°C.
Voltage—400 V peak.

ORDERING INFORMATION

P6602 1.5 m Temperature Probe **$235**
Includes: Instruction manual (070-4377-00).
P6407 Word Recognizer Probe—See page 363 for specifications and ordering information.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99

TEKTRONIX CURRENT PROBES

Current probes provide a method to measure the current flowing in a circuit from dc to 1000 MHz. For instance, their use can eliminate the calculations that would be required to determine the current from the voltage drop across a current sampling resistor.

Two types of current probes are available, the traditional ac only probe and the "Hall effect" type. Ac only current probes use a transformer to convert current flux into ac signals and have a frequency response from a few hundred hertz to 1000 MHz. Hall effect current probes include semiconductors to provide a frequency response from dc to 50 MHz.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the mΩ to low Ω range. Current probes can be used for differential measurements; where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current dependent circuit. Measuring only the voltage will not show this difference. A measurement of the current waveform is necessary to obtain the total picture.

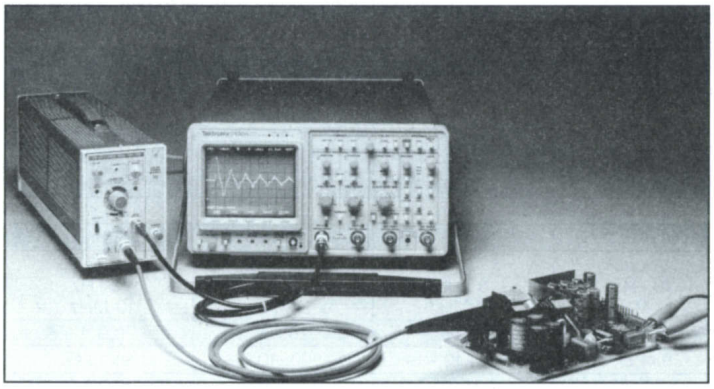
A current probe is used by clipping its jaws around the wire that is carrying the current to be measured. Because it is "noninvasive", a current probe imposes less loading than other probes (typically less than a few nanohenrys in series with the wire at a capacitance of less than 1 pF). Differential current measurements are made by passing the two wires (in correct phase) through the current probe jaws.

The CT-4 increases the high-current measuring capability of most current probes by either 20:1 or 1000:1.

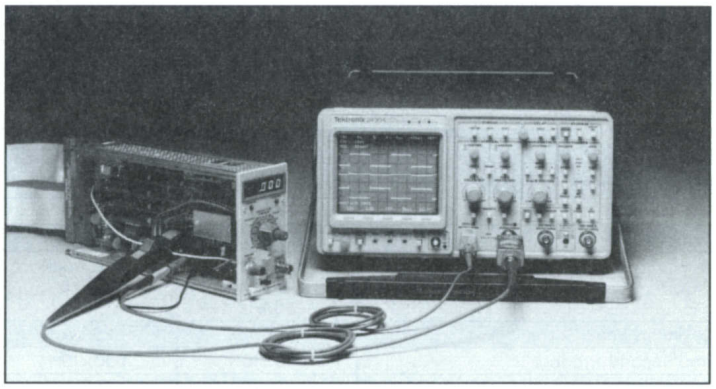
CURRENT PROBE SELECTION GUIDE

Type	Bandwidth Hz to MHz (−3 dB)	Maximum Current: Pulse Peak	Maximum Current: DC + pk AC	Maximum Current: AC P-P	Maximum Current: Derate Below	Maximum Current: Derate Above	Saturation: DC	Saturation: Amp-S Product	Saturation: Display Sensitivity Range in Current/Div.	Prices
A6302/AM 503 with CT-4	DC to 50	50 A	20 A	40 A		20 kHz	20 A	100×10^{-6}	1 mA to 5 A*1	$1,780
	0.5 to 20	1 kA		1 kA	20 Hz	1.2 kHz		0.1	20 mA to 5 kA*1	$3,040
A6303/AM 503	DC to 15	500 A	100 A	200 A		20 kHz	100 A	$10{,}000\times10^{-6}$	10 mA to 50 A*1	$2,305
P6021 with Passive Termination and CT-4	120 to 60	250 A		15 A	300 Hz	5 MHz	0.5 A	500×10^{-6}	20 mA*1 or 100 mA*1	$450
	120 to 20	1 kA		1 kA	300 Hz	1.2 kHz	20 A	0.5	400 mA*1 or 100 A	$1,710
P6021 with 134 and CT-4	12 to 20	250 A		15 A	230 Hz	5 MHz	0.5 A	500×10^{-6}	1 mA to 1 A*2	$1,100
	25 to 20	1 kA		1 kA	230 Hz	1.2 kHz	20 A	0.5	20 mA to 1 kA*2	$2,360
P6022 with Passive Termination with 134	935 to 120	100 A		6 A	3 kHz	10 MHz	0.2 A	9×10^{-6}	10 mA or 100 mA*1	$495
	100 to 65	100 A		6 A	1.3 kHz	10 MHz	0.2 A	9×10^{-6}	1 mA to 1 A*2	$1,145
CT-1	25 k to 1000	12 A		1.4 A			0.2 A	1×10^{-6}	2.0 mA*1 (5 mV/mA)	$230
CT-2	1.2 k to 200	36 A		7 A			0.2 A	50×10^{-6}	10.00 mA*1 (1 mV/mA)	$210

*1 *Scope set at 10 mV/div.*
*2 *Scope set at 50 mV/div.*

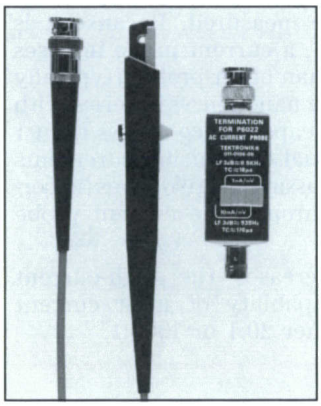


A6302, AM 503, TM 501, and 2430A scope.



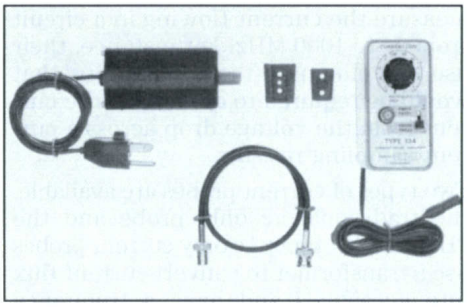
P6021, P6131, and 2430A scope.

P6021
With Termination



P6022
With Termination

134 Current Probe Amplifier



- **For 1 MΩ Inputs**
- **Clip-on Capability**
- **Shielded Probe Heads**

The P6021 and P6022 Current Probes and 134 Current Probe Amplifier provide versatility in a user-assembled ac current measurement system. Both probes provide accurate current measurements over a wide range of frequencies and are used with real time oscilloscopes. The P6021 and P6022 allow current measurements without breaking the circuit by clipping onto the current carrying conductor. Just open the spring-loaded slide, place the conductor into the slot and release the slide. No electrical connection is required.

Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the circuit under test.

P6021 Current Probe

For general purpose applications the P6021 provides wide-band performance with excellent low-frequency characteristics. Bandwidth is 120 Hz to 60 MHz. Passive termination is switchable from 2 mA/mV to 10 mA/mV.

P6022 Current Probe

The extra small size of the P6022 makes it ideally suited to measure current in compact semiconductor circuits. Bandwidth is 935 Hz to 120 MHz. Passive termination is switchable from 1 mA/mV to 10 mA/mV.

134

The 134 is used to extend the measurement capabilities and sensitivity of the P6021 or P6022 Current Probes. A Current/Div switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 with a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the Current/Div switch in the Volts position.

ORDERING INFORMATION

P6021 5 ft Current Probe With Termination **$450**
Includes: 5 in (130 mm) ground lead (G7, 175-0124-01); 3 in (75 mm) ground lead (G7, 175-0263-01); 2 miniature alligator clips (A15, 344-0045-00); instruction manual (070-0947-00).
P6022 5 ft Current Probe With Termination **$495**
Includes: Same as the P6021; instruction manual (070-0948-00).

OPTIONS

Option 03—9 ft with termination. **NC**
Option 12—5 ft w/out termination.
(P6021) **−$60**
(P6022) **−$95**
Option 13—9 ft w/out termination.
(P6021) **−$60**
(P6022) **−$95**
134 110 V Current Probe Amplifier **$650**
Includes: Hanger assembly (014-0029-00); cable assembly (012-0104-00); instruction manual (070-0990-01).

OPTIONAL ACCESSORIES

Carrying Case—For P6021 or P6022, and a 134 Amplifier. Order 016-0087-01 **$30**
Passive Termination—
(P6021) Order 011-0105-00 **$120**
(P6022) Order 011-0106-00 **$145**
Power Supply—
(110 V ac) Order 015-2199-00*[1]

*[1] *Contact your local Sales Office.*

PERFORMANCE CHARACTERISTICS

	P6021 with Passive Termination		P6022 with Passive Termination		Probe with 134 Amplifier	
					P6021	P6022
Accuracy 3% Sensitivity	2 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	1 mA to 1 A/div @ 50 mV/div	
Bandwidth Low −3 dB High −3 dB	 450 Hz 60 MHz	 120 Hz 60 MHz	 8.5 kHz 100 MHz	 935 Hz 120 MHz	 12 Hz 38 MHz	 100 Hz 65 MHz
Rise Time	5.8 ns	5.8 ns	2.7 ns	1.7 ns	9.2 ns	5.4 ns
Droop TC	0.35 ms	1.3 ms	18.7μs	0.17 ms	13 ms	1.6 ms
Maximum AC CW From To	15 A peak 1.2 kHz 5 MHz	15 A peak 300 Hz 5 MHz	6 A peak 10 kHz 10 MHz	6 A peak 3 kHz 10 MHz	15 A peak 230 Hz 5 MHz	6 A peak 1.3 kHz 10 MHz
Maximum Peak Current	250 A	250 A	100 A	100 A	250 A	100 A
Amp/Second Product	500×10^{-6}	500×10^{-6}	9×10^{-6}	9×10^{-6}	500×10^{-6}	9×10^{-6}
Maximum DC	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A
Insertion Z (Ω)	0.03 @ 1 MHz 1.0 @ 60 MHz		0.03 @ 1 MHz 0.2 @ 120 MHz		0.03 @ 1 MHz 1.0 @ 38 MHz	0.03 @ 1 MHz 0.2 @ 65 MHz
Propagation Delay (ns) 5 ft 9 ft	 9 15	 9 15	 9 15	 9 15	 9 15	 9 15
Maximum Voltage Barewire	600 V	600 V	600 V	600 V	600 V	600 V
Net Weight	≈1 lb		≈1 lb		≈5 lb	
Maximum Conductor Size	0.15 in. dia		0.1 in. dia		0.15 in dia	0.1 in. dia
Operating Temperature	0 to +50°C		0 to +50°C		0 to +50°C	

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99

A6302 Current Probe

- **20 A AC and DC Current Measurements**
- **DC to 50 MHz Bandwidth**
- **Peak Pulse Measurements to 50 A, 1,000 A With the CT-4 Current Probe**
- **AC or DC Coupling**
- **Small Loading—0.1 Ω Insertion Z at 1 MHz, 0.5 Ω at 50 MHz**

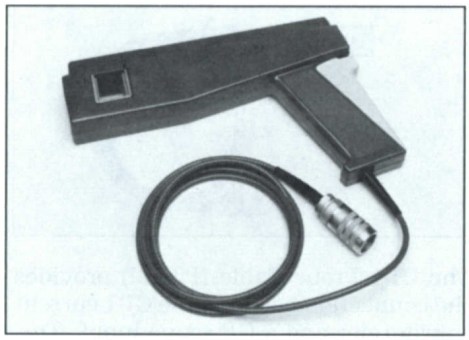
The A6302 and A6303 Current Probes are designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope. Both probes are used to make SCR, power supply, industrial control and motor start-up current measurements. The A6303 is recommended for measuring current in X-ray tubes to ensure compliance with PL 90-602, the Radiation Control for Health and Safety Act of 1968.

The A6302 and A6303 are valuable measurement tools when low loading is important, as when testing high impedance points or with current dependent devices. Both probes make ac or dc coupled current measurements simply by opening the sliding jaws and placing them around the conductor to be measured. For differential or sum measurements, just place properly phased conductors in the probe jaw.

Suggested measurements for the A6302 and A6303 Current Probes include:

- X-ray tube currents
- SCR currents
- Power supply currents
- Motor start-up currents
- Industrial control currents
- Relay currents
- Common-mode rejection of dc and ac currents

A6303 Current Probe



- **100 A AC and DC Current Measurements**
- **Peak Pulse Measurement to 500 A**
- **AC or DC Coupling**
- **25×21 mm (1×0.83 in.) Jaw Opening**
- **Minimal Loading—0.02 Ω Insertion at 1 MHz, 0.15 Ω at 15 MHz**

CHARACTERISTICS

	A6302/AM 503*1	A6303/AM 503*1
Sensitivity: Scope @ 10 mV/div Accuracy 3%	1 mA/div to 5 A/div	10 mA/div to 50 A/div
Bandwidth	DC to 50 MHz	DC to 15 MHz
Rise Time	7 ns	23 ns
Max AC Current CW	40 A p-p	200 A p-p
Derated Above	20 kHz 2.5 A @ 10 MHz	20 kHz 12 A @ 10 MHz
Maximum Peak Current Not to Exceed A-S Product	50 A	500 A
A-S Product	100×10^{-6}	$10{,}000\times10^{-6}$
Insertion Z	0.1Ω @ 5 MHz 0.5Ω @ 50 MHz	0.02Ω @ 1 MHz 0.15Ω @ 15 MHz
Max Hardware Volts	500 V	700 V
Max Conductor Diameter	0.15 inch	0.83 inch
System Prop Delay	≈30 ns	≈40 ns
Cable Length	2 m	2 m
Tangential Noise	0.3 mA	3 mA
Aberrations	±5%	±5%
Magnetic Susceptibility	250 μA/Gauss	25 mA/Gauss
Operating Temp	0 to +50°C	0 to +50° C

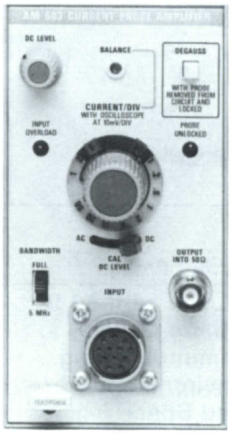
*1 *A6302/AM 503 or A6303/AM 503 calibrated as a set.*

ORDERING INFORMATION

A6302 2 m Current Probe **$595**
Includes: 5 in (130 mm) ground lead (G7, 175-0124-01); 3 in (75 mm) ground lead (G7, 175-0263-01); 2 miniature alligator clips (A16, 344-0046-00); instruction manual (070-3905-01).
A6303 2 m Current Probe **$1,120**
Includes: Carrying case (016-0622-00); instruction manual (070-3906 01).

AM 503 Current Probe Amplifier

For 50 Ω/1 MΩ



The AM 503 operates in any one of the TM 500 power modules and is connected to the A6302 or A6303 probes through a multipin connector.

It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. AC coupling allows the measurement of low amplitude signals on a high level dc current. A front panel light warns of input currents above 100 A dc with the A6303 or 20 A dc with the A6302. A pushbutton allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the A6303/AM 503 can be displayed on any oscilloscope that has at least a 50-MHz bandwidth and a 10 mV sensitivity. The A6302/AM 503 can be used on a 100-MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50 Ω recording instrument, or a 50 ohm termination which is supplied. See page 461 for specific specifications.

Note: To achieve optimum performance the current probe, current probe amplifier, and oscilloscope should be calibrated as a system.

ORDERING INFORMATION

AM 503 Current Probe Amplifier **$1,185**
Includes: 50Ω BNC cable (012-0057-01); 50Ω BNC termination (011-0049-01); instruction manual (070-2052-01).

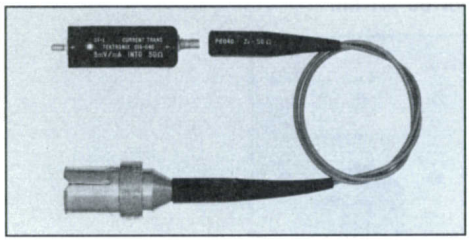
The AM 503 requires one of the TM 500 Series power modules. See Modular Instruments section.

TM 501 Power Module **$500**
TM 502A Power Module **$235**
TM 503 Power Module **$400**
AM 503S Current Probe System **$2,015**
Includes: AM 503 Current Probe Amplifier; TM 502A Power Module; A6302 Current Probe.

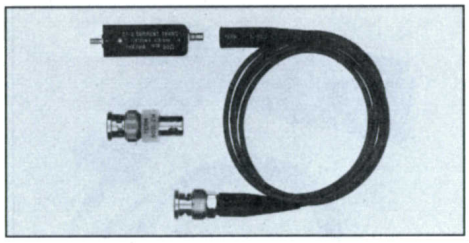
OPTIONS

Option 01—A6303 Current Probe. **+$1,120**
Option 03—Substitute A6303 for A6302. **+$525**

CT-1 With Probe Cable



CT-2 With Probe Cable



CT-1/CT-2 Current Probes

- **The 1 GHz CT-1 is Used with 50 Ω Systems, or Wide Band Oscilloscopes; Has a Minimum Loading Effect on a 50 Ω Environment**
- **Insulated for Limited Space Applications**

The CT-1 and CT-2 Current Probes are designed for permanent or semipermanent in-circuit installation. Each probe consists of a current transformer, an interconnecting cable and a termination. The current transformers are traversed by a small hole through which a current carrying conductor is passed during circuit assembly. One probe cable can be used to monitor several current transformers that have been wired into a circuit.

CHARACTERISTICS

	CT-1	CT-2
Sensitivity	5 mV/mA	1 mV/mA
Accuracy	±3%	±3%
Rise Time	350 ps	500 ps
Frequency Response*1 Low: −3 dB High: −3 dB	 25 kHz 1 GHz	 1.2 kHz 700 MHz
Insertion Impedance at: 10 MHz 100 MHz	 ≈1Ω 2Ω	 0.1Ω 0.5Ω
Capacitive Loading Barewire	1.5 pF for #14	1.8 pF for #16
Maximum Barewire Voltage	1000 V	1000 V
DC Saturation Current: Current to Reduce L/R by X2	75 mA	175 mA
Pulse Current Rating*2	12 A	36 A
Not to Exceed: Amp S Product*2 Maximum CW Current*2 Cable Length Prop Delay Cable Connector	 1×10^{-6} 450 mA 18 inch 3.25 ns GR874	 50×10^{-6} 2.5 A 42 inch 6.1 ns BNC
Operating Temperature	−25 to +65°C	

*1 *System B/W= √probe B/W+scope B/W.*
*2 *With 50 Ω termination. Values are reduced by a factor of 2 if unterminated.*

The CT-1 Probe Cable (P6040) provides the connection between the CT-1 current transformer and a GR scope input. This cable can also be used with other test point connectors such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF connectors.

The CT-2 Probe Cable (P6041) is used to connect the CT-2 current transformer with a BNC oscilloscope input. A 50 Ω termination is used to terminate the cable at the high impedance input of an oscilloscope.

ORDERING INFORMATION

CT-1 Current Probe, Current Transformer and Probe Cable, Termination **$230**
Includes: Instruction manual (070-0375-01).

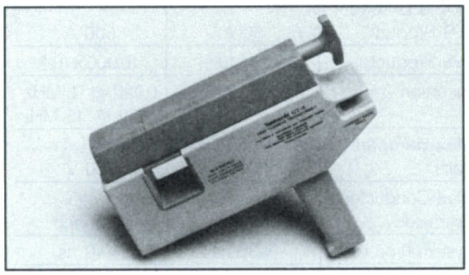
OPTIONS

Option 09—Current Transformer only. **−$90**
P6040—Probe Cable only. **$99**

CT-2 Current Probe, Current Transformer, Probe Cable, Termination **$210**
Includes: 50 Ω termination (011-0049-01); instruction manual (070 0406-01).

OPTIONS

Option 09—Current Transformer only. **−$60**
P6041—Probe Cable only. **$65**



CT-4

Continuous Currents Up to 1000 A Peak

- **1.5 Inch Diameter Conductors**
- **Measurements on Bare Conductors to 3000 V**
- **Nullifies DC Effects to 300 A with DC Bucking Coil**
- **Pulsed Currents to 1 kA**

The CT-4 is a clip-on high current transformer that extends the measurement capability of the P6021 and A6302 clip-on current probes. Maximum low frequency performance is obtained using the A6302/AM 503. Pulse current to 1,000 amps may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 may be used for measurements at normal line frequency and above. (The P6022 and A6303 are not compatible with the CT-4.)

The CT-4 has receptacles for current probes current probes in either 20:1 or 1000:1 step-down ratios.

The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. Insulated core and shield assemblies allow measurements on bare wires to 3000 V, and to 10 kV RMS with a high voltage bushing.

A dc bucking coil assembly allows up to 300 A of dc to be nullified (derates to 1 MHz B/W). This is very useful for measuring ac signals on top of a dc voltage level.

CHARACTERISTICS

The following are characteristics of the CT-4 using either the A6302/AM 503 or P6021/134 combinations.

Rise Time—≈17.5 ns.
Insertion Impedance—≈ ≤20 μΩ at 60 Hz and 30 mΩ at 1 MHz.
Current Display Range—20 mA/div to 100 A/div with A6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with A6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio).
Maximum Current—Up to 1,000 A peak.
Accuracy—±4% when less than 20 A dc current present.
Maximum Voltage of Circuit Test—3000 V (barewire). 10 kV RMS with high voltage bushing.
Maximum DC Bucking Current—300 mA to buck out 300 A dc (using dc bucking coil).

CURRENT MEASUREMENT COMBINATIONS*1

Product	Band-width	A-s Product	Maximum Current RMS	Maximum Current Peak Pulse
CT-4/ A6302/ AM 503	0.5 Hz to 20 MHz	0.1	700 A	1 kA
CT-4/ P6021/134	25 Hz to 20 MHz	0.5	700 A	1 kA
CT-4/ P6021/ Term	120 Hz to 20 MHz	0.5	700 A	1 kA

*1 *Maximum Current—RMS:700 A. Peak Pulse: 1 kA.*

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	57	2.3
Height	241	9.5
Depth	266	10.5
Weight ≈	**kg**	**lb**
Net	1.8	4.0

ORDERING INFORMATION

CT-4 Current Probe With DC Bucking Coil **$1,260**
Includes: Carrying case (016-0191-03); 12 in wide, 4 ft long high voltage bushing (015-0194-00); DC Bucking Coil (015-0190-00); instruction manual (070-6478-00).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99

Floating Measurement Techniques

The industries' need for oscilloscope measurements referenced to voltage levels above/below ground potential has long been recognized. The need to reject signals represents another closely allied measurement requirement. These needs often lead users to employ practices which may distort the waveform measurement or are unsafe. Tektronix offers three safe techniques to solve these measurement problems.

Isolation Amplifiers

The A6902B is a voltage isolation amplifier used to connect the circuit under test and the oscilloscope. Signals are coupled across an insulating barrier to the oscilloscope. The isolator provides complete insulation from the signal, no access to dangerous voltages, and complete usability of all oscilloscope functions.

Differential Techniques

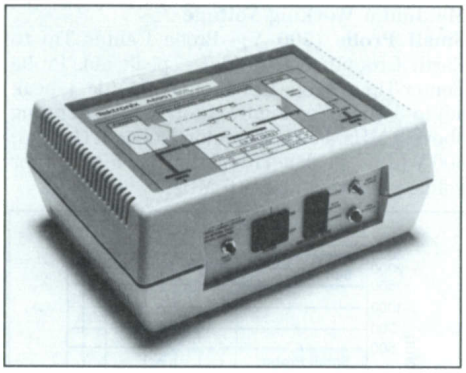
The most popular solution for a floating measurement is the A minus B quasi-differential technique. Most general-purpose dual-trace oscilloscopes have an Add Mode in which two channels can be electrically subtracted, giving a display of the difference signal. This technique limits the common-mode dynamic range and the CMRR to approximately 100:1. Also, examination of low-level signals in the presence of high common-mode voltages can be difficult.

True differential amplifiers like the 7A13 are designed specifically to have good rejection of the common-mode signal and display only the difference signal. Common-mode dynamic range is improved but there are bandwidth and floating capability limitations.

Using both A6902B channels as differential input to a 7A13, 7A22 or oscilloscope provides an extra measure of common-mode performance. The isolator probes' common leads are tied together and the signal leads are then used as plus and minus differential inputs to test the circuit. This technique provides the protection of the isolator as well as the combined CMRR capabilities of the isolator and amplifier.

Indirect Grounding

The A6901 Ground Isolation Monitor is an indirect grounding device which connects between the power mains and the test instruments, allowing monitored floating measurements. As specified in safety standards, the grounding circuit to the test instrument need not be completed until the available voltage or current exceeds a prescribed amount (40 V peak or 28 V RMS). When this amount is exceeded



the power to the instrument is interrupted, a protective ground is reestablished, and an audible alarm is sounded. The A6901 also verifies the existence of a functional ground in the power source.

A6901

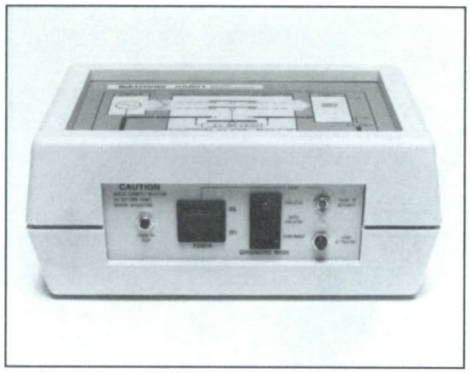
- **Permits Elevation of Test Instrument Chassis to 40 V Peak (28 V RMS)**
- **Aids in Circuit Analysis or Circumventing Ground Loop Noise Problems**
- **UL and VDE Safety Certification**

The A6901 is placed between a measurement instrument and its power source and acts as an indirect grounding device, allowing floating measurements to be made with operator protection.

The A6901 monitors the voltage on the isolated system. When the voltage exceeds 40 V peak (28 V RMS) the power source to the instrument is interrupted, the isolated grounding system is connected to the power source grounding system, and an audible alarm is sounded. Before power is supplied to the measurement instrument, the A6901 tests the power source for a functional ground*[1]. If a functional ground is not established, the ground isolation monitor will not go into isolated mode.

Applications for the A6901 include elevating a test instrument chassis to logic reference voltages for more accurate logic level measurements, and isolating a test instrument chassis from common-mode voltages present on ground systems to eliminate undesirable noise from signal measurements. The A6901 also can be used to test power outlets for proper wiring.

*[1] *If the A6901 is used in conjunction with a GFI (Ground Fault Indicator), consult the GFI manual for compatibility information.*



CHARACTERISTICS

ELECTRICAL

Trip Voltage (DC)—40 V peak (28 V RMS) or + and −40 V (within 5%).
Trip Current—0.5 mA, 3.5 to 5 mA selectable.
Neutral-to-Ground Continuity—Between 3 and 10 V RMS (8.5 and 28.3 V p-p), 50 Hz.
DC Voltage Trip Delay—<20 ms.
Line Voltage Ranges—90 to 128 V RMS, 180 to 250 V RMS.
Line Frequency Range—48 to 66 Hz.
Maximum Power Consumption (No External Load)—12 W at 115 V, 60 Hz.
Load Power—500 W maximum.

ENVIRONMENTAL

Temperature Operating: −15 to +55° C (+5 to +131° F). Nonoperating: −62 to +85° C (−80 to +185° F). Meets MIL-T-28800B, Class 3.
Altitude—Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft). Exceeds MIL-T-28800B, Class 3.
Humidity—Exceeds MIL-T-28800B, Class 3.

PHYSICAL CHARACTERISTICS

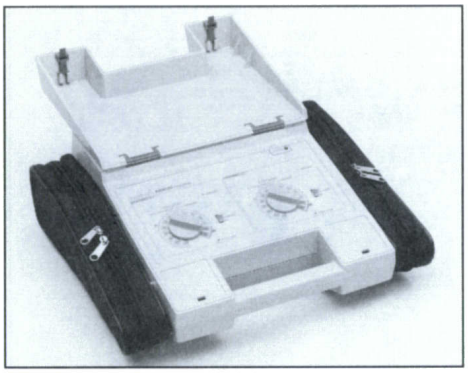
Dimensions	mm	in.
Height	87	3.4
Width	206	8.1
Depth	153	6.0
Weights ≈	**kg**	**lb**
Net (w/o accessories)	1.4	3.0
Shipping	2.3	5.0

ORDERING INFORMATION

A6901 Ground Isolation Monitor **$680**
Includes: Operator manual (070-3618-00).

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.
Option A2—UK 240 V, 50 Hz.
Option A3—Australian 240 V, 50 Hz.
Option A5—Switzerland 220 V, 50 Hz.
(North American 240 V not available. Neutral not grounded in 240 V North American Systems.)



A6902B

For 50 Ω or 1 MΩ Inputs

- **Two Independently Isolated Channels**
- **High Voltage/High CMRR**
- **UL Certified to 3000 V/Channel (6000 V Maximum Channel Differential)**
- **DC to 20 MHz Bandwidth**

A dual-channel, optical- and transformer-coupled voltage isolator, the A6902B allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common mode signals.

The A6902B acts as a buffer between the test instrument and the system under test and extends the range of the test instrument to 3000 V (dc plus peak ac) with the larger industrial probe and to 500 V (dc plus peak ac) with the smaller signal probe. Both probes are quickly interchangeable at the cable connectors, and can be stored in convenient, removable side pouches.

Designed for use with any dual-channel oscilloscope, the A6902B permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages. The two channels can be combined to function as an input to a differential amplifier.

Separate, calibrated controls for volts per division on each channel allow precise floating measurements. The plastic case and external controls protect the user during control settings and other operations. Other than probe tip connections, the user is never in close proximity to hazardous voltages.

CHARACTERISTICS

ELECTRICAL

Deflection Factor—Probe Tip Sensitivity: 20 mV/div to 500 V/div in 1-2-5 sequence with oscilloscope set to 10 mV/div. Accuracy: ≤ ±5% of indicated V/div switch setting.

Frequency Response Bandwidth—DC coupled (to −3 dB point) is ≥ 20 MHz. AC coupled (to lower −3 dB point) is ≤ 5 Hz to ≥ 20 MHz.

Transient Response—Rise time: 17.5 ns (calculated from bandwidth).

Maximum Working Voltage

Small Probe (500 V)—Probe Center Tip to Earth Ground: 500 V (dc + peak ac). Probe Center Tip to Probe Common: 500 V (dc + peak ac) to 3 MHz. See Figure 2 for voltage derating above 3 MHz. Probe Common to Earth Ground: 500 V (dc + peak ac) to 6 MHz. See Figure 2 for voltage derating above 6 MHz.

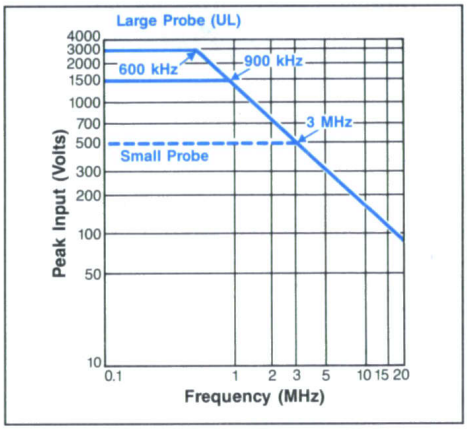


Figure 1. Maximum working voltage between probe input and probe common (all temperatures).

Large Probe (DC Coupled)—Probe Center Tip to Earth Ground: UL 3000 V. Probe Center Tip to Probe Common: UL 3000 V (dc + peak ac) to 450 kHz. See Figure 1 for voltage derating above 900 kHz. Probe Common to Earth Ground: UL 3000 V (dc + peak ac) to 250 kHz. See Figure 2 for voltage derating above 250 kHz.

Large Probe (AC Coupled)—Probe Center Tip to Earth Ground: 500 V (dc + peak ac).

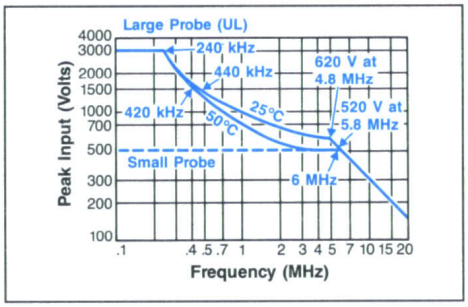


Figure 2. Maximum working voltage between probe common and earth ground.

Maximum Input dV/dt—100 V/ns.

Input Impedance—Resistance: 10 MΩ ±3%. Capacitance: ≈19 pF with either probe.

Output Impedance—50 Ω ±5%.

Output Drive—4 V p-p into 1 MΩ.

Common-Mode Capacitance—100 pF from probe common to earth ground.

Maximum Common to Ground Slew Rate—500 V/μs.

Tangential Noise—≤20 mV. DC Drift With Temperature: ≤10 mV/°C (0.1 div/°C) at output. Range of Output DC Level: At least +5 div from center screen.

Channel Isolation—Maximum Voltage: Using two 3,000 V UL probes is 6000 V (dc + peak ac) UL. Using two 500 V probes is 1000 V (dc +peak ac).

Delay—51 ns ±3 ns (large probe), 52 ns ±3 ns (small probe), from probe input to instrument input. CH 1, CH 2 delay difference is ≤4 ns.

Common Lead Signal Feedthrough—−106 dB from probe input to output BNC to 500 Hz.

See Figure 3 for derating above 500 Hz.

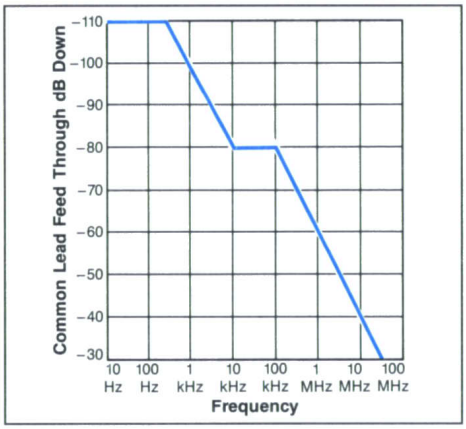


Figure 3. Common lead feedthrough characteristics.

POWER REQUIREMENTS

Line Voltage Ranges—Low: 90 to 132 V. High: 180 to 250 V.

Line Frequency Range—48 to 440 Hz.

Maximum Power Consumption—24 W at 115 V, 60 Hz.

ENVIRONMENTAL

Temperature—Operating: 0 to +50°C. Nonoperating: −55 to +75°C.

Altitude—Operating: To 4500 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Humidity (Operating and Nonoperating)—Five cycles (120 hr total) with equipment tested nonoperating to MIL-STD-810C Method 507.1, at 90 to 95% relative humidity and 30 to 60°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	136	5.4
Width	394	15.5
Depth	344	13.5
Weight ≈	**kg**	**lb**
Net w/Accessories	6.2	13.7
Shipping	8.0	17.7

ORDERING INFORMATION

A6902B Voltage Isolator **$1,885**

Includes: Two 500 V isolation probes (010-0411-15); right angle power cord (161-0117-00); two 2 m, 50 Ω output cables (012-0204-00); operator manual (070-5614-00).

OPTIONS

Option 02—Add two large probes. **+$470**

Option 09—Add two large probes plus two 4 mm banana adapters. **+$535**

INTERNATIONAL POWER PLUG OPTIONS

Option A1—Universal Euro 220 V, 50 Hz.

Option A2—UK 240 V, 50 Hz.

Option A3—Australian 240 V, 50 Hz.

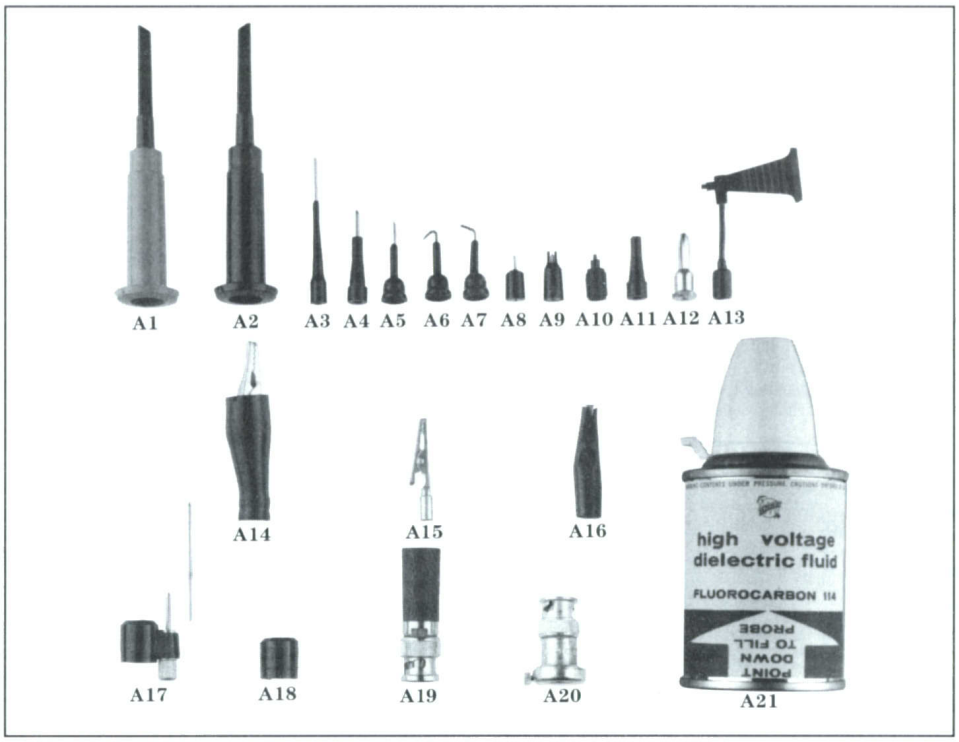
Option A4—North American 240 V, 60 Hz.

Option A5—Switzerland 220 V, 50 Hz.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext. 99

P6006, P6007, P6008, P6009, P6015, P6028 and P6060 probes which have #6-32 screw tips.

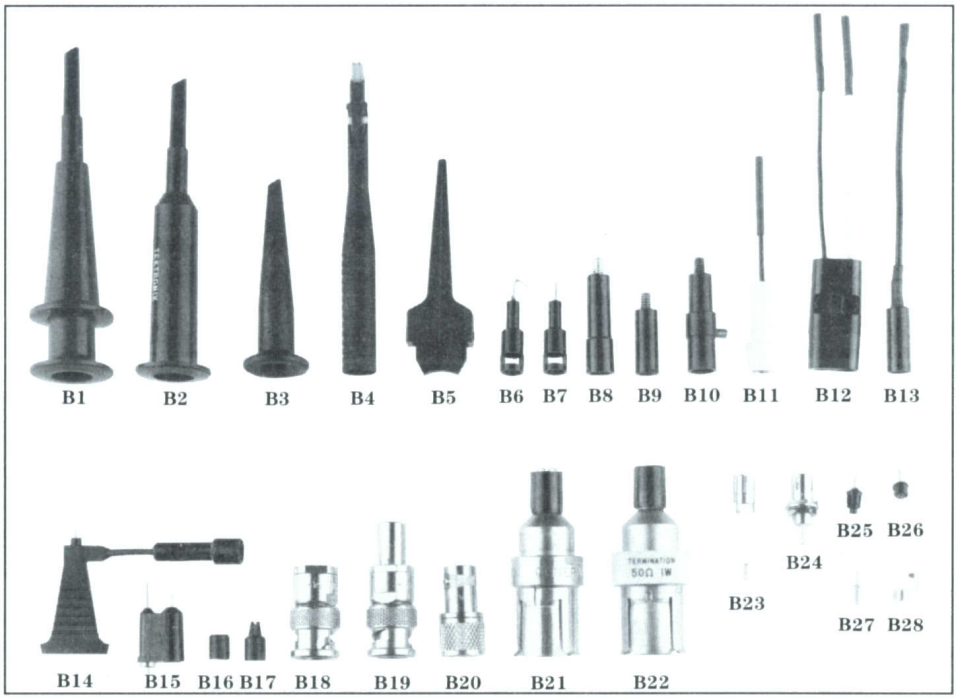
Code	Description	Part No.	Price
A1	Retractable hook tip	013-0071-00	$4.25
A2	Retractable hook for P6008 environmental	013-0071-01	$4.75
A3	Calibration tip (0.063 in dia)	206-0100-00	$11.50
A4	Spring tip (0.08 in dia)	206-0060-00	$2.85
A5	Long straight tip (0.032 in dia)	206-0104-00	$1.50
A6	Hook tip	206-0105-00	$1.50
A7	Right angle hook tip	206-0185-00	$1.75
A8	Straight tip (0.055 in dia)	206-0015-00	$1.40
A9	IC test tip	206-0203-00	$1.75
A10	Ground lead adapter (0.025 in square pin closing)	206-0137-01	$4.00
A11	Spring tip (accepts 0.065 in dia pin)	206-0061-00	$1.85
	(accepts 0.068 in dia pin)	206-0168-00	$3.90
A12	Banana tip	134-0013-00	$1.30
A13	Pin tip (accepts 0.025 in IBM SLT pin)	206-0134-03	$6.50
A14	Alligator clip for P6015	344-0005-00	$4.95
A15	Alligator clip	344-0045-00	$.85
A16	Miniature alligator clip	344-0046-00	$2.50
A17	Bayonet ground assembly	013-0052-00	$10.75
A18	Insulating ground cover for P6009	166-0428-00	$1.55
A19	Probe screw tip to BNC adapter	013-0054-00	$16.00
A20	Probe screw tip to BNC adapter for P6028	013-0056-00	$22.00
A21	High voltage dielectric fluid 3 oz	252-0120-00	$6.50



P6053B, P6055, P6056, P6057, P6062B, P6063B, P610X Family, P612X Family, P6148, P6149A, and P6202A miniature tip probes.

Code	Description	Part No.	Price
B1	Retractable hook tip (except P612X)	013-0105-00	$9.25
B2	Retractable hook tip (for P6202A and P6420)	013-0097-01	$11.00
B3	Retractable hook tip (for all except P6202A and P6420)	013-0107-05	$2.90
B4	IC grabber	013-0191-00	$8.25
B5	Miniature retractable hook (used with adapters B11 and B12)	206-0222-01	$4.05
B6	Hook tip	206-0114-00	$3.50
B7	Straight tip	206-0114-01	$3.50
B8	Screw tip (#6-32)	103-0051-01	$4.95
B9	Screw tip (#6-32 for P6202A and P6420)	103-0051-00	$4.95
B10	Screw tip with ground connection (#6-32)	103-0131-00	$11.00
B11	Flexible tip (accepts B5 retractable hook)	103-0177-01	$8.25
B12	Dual lead adapter (accepts B5 retractable hook)	015-0325-00	$19.25
B13	Flexible tip for 0.025 in square pin	206-0193-00	$9.50
B14	Pin tip (accepts 0.025 in IBM SLT pin)	206-0209-00	$4.75
B15	Bayonet ground assembly	013-0085-00	$9.25
B16	Insulating ground cover	166-0404-01	$1.30
B17	IC test ground cover Package of 10	015-0201-04	$7.00
	Package of 100	015-0201-05	$20.00
B18	Miniature probe tip to BNC adapter	013-0084-01	$10.00
B19	Miniature probe tip to BNC adapter (for all except P6202A)	013-0084-02	$14.00
B20	Miniature probe tip to BNC female adapter	103-0096-00	$13.75
B21	Miniature probe tip to GR adapter	017-0076-00	$65.00
B22	Miniature probe tip to GR 50 Ω termination adapter	017-0088-00	$70.00
B23	Circuit board test point Outer case	131-1436-00	$6.25
	Inner connector (need to order both for one test point)	136-0333-00	$.50
B24	Chassis mount test jack	131-0258-00	$3.70
B25	Replaceable probe tip (for all except P6202A/P6420/ and P610X "A" versions*1 probes) Package of 10	206-0191-03	$22.00
B26	Replaceable probe tip (for P6202A/P6420) Package of 10	206-0230-03	$22.00
B27	Replaceable probe tip (for P6103/P6109) Package of 5	131-3723-01	$6.00
B28	Electrical ground contact	214-0283-00	$1.25

*1 *For "A" versions, refer to page 531, Modular Probe Replacement Subassemblies.*

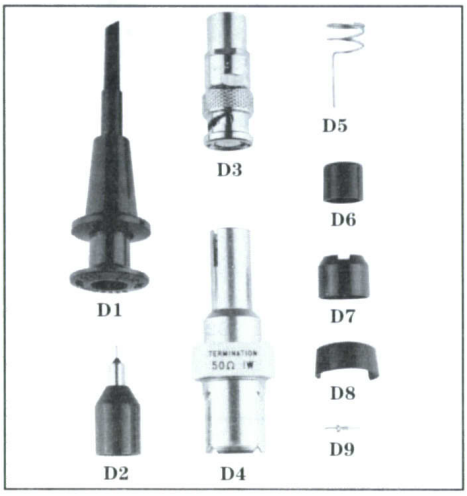


P613X Family and P6230 subminiature tip probes.

Code	Description	Part No.	Price
C1	Retractable hook tip	013-0208-00	*1
C2	Subminiature-to-miniature probe tip adapter (allows use of miniature probe tip accessories)	013-0202-02	$5.00
C3	Subminiature probe tip to BNC adapter	013-0195-00	$9.75
C4	Subminiature probe tip to GR 50Ω termination adapter	017-0520-00	$70.00
C5	Circuit board test points		
	Outer shell (pkg of 100)	131-2766-01	$47.00
	Inner connector (pkg of 100)	136-0352-02	$24.00
C6	KLIPKIT (includes two 16-pin DIP clips and four signal/ground pins)	013-0197-00	$46.00
C7	Signal/ground pins for KLIP-KIT (includes eight pins)	131-3288-02	$29.00

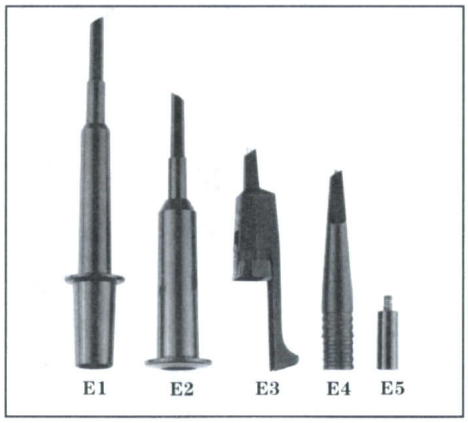
P6201 Probes

Code	Description	Part No.	Price
D1	Retractable hook tip	013-0135-00	$7.75
D2	Probe tip to miniature probe tip adapter	103-0164-00	$9.00
	Probe tip to BNC adapter	013-0145-00	$24.00
D4	Probe tip to GR 50Ω termination adapter	017-0094-00	$90.00
D5	Ground contact	131-1302-00	$1.20
D6	Insulating ground cover	166-0557-00	$2.30
D7	Ground contact insulator	342-0180-00	$1.50
D8	Ground lead insulator	166-0433-00	$1.20
D9	Replaceable probe tip	206-0200-00	$1.20



Other Probes

Code	Description	Part No.	Price
E1	Retractable hook tip (for P6010/P6048)	013-0090-00	$7.25
E2	Retractable hook tip (for S-3A/P6202A/P6420)	013-0097-01	$11.00
E3	Retractable hook tip (for 7A11/P6401)	013-0106-00	$18.50
E4	Retractable hook tip (for 211/212/213/214/221 scope probes)	013-0107-02	$3.50
E5	Screw tip (#6-32 for P6045/P6046/P6202A/7A11/S-3A)	103-0051-00	$4.95



Cable Marker Sets (not pictured)

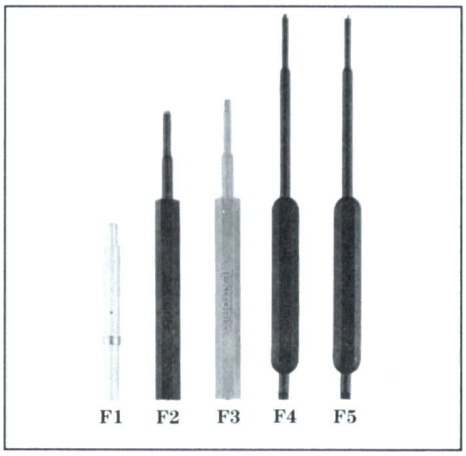
Description	Part No.	Price
FOR 1/8 in dia cable (P6053B/P6062B/P6063B/P6075)	016-0130-00	$7.00
FOR 3/16 in dia cable	016-0127-00	$7.00
FOR All modular cables (P610XA/P612X/P613X/P6230 families)	016-0633-00	$4.25

Ground Leads

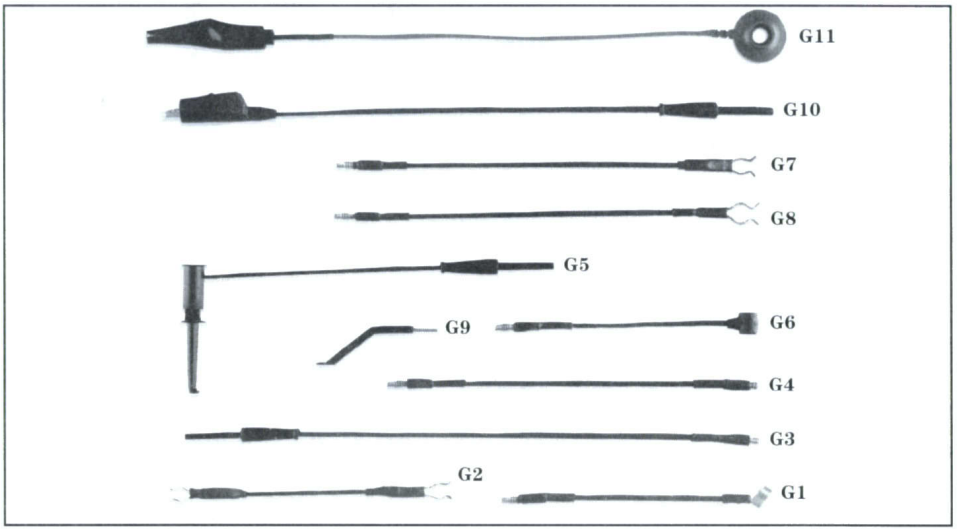
Code	Description	Part No.	Price
G1	Probe tip clip-on lead for all miniature size probe tips 3 inches	195-6176-00	$6.25
G2	Clip-on interconnect for P6055 6 inches	175-1256-00	$5.50
G3	Lead for P612X/P613X/P6230 families 12 inches	195-1870-01	$7.00
G4	Screw-in lead for P6054/P6075/P6201/7A11 probes		
	3 inches	175-0848-00	$2.60
	5 inches	175-0848-01	$2.25
	12 inches	175-0848-02	$2.80
G5	Microhook for P612X/P613X/P6230 families 6 inches	195-4104-00	$9.50

Probe Tools

Code	Description	Part No.	Price
F1	Tip extractor for miniature probes (except for P610X "A" version and P612X family probes)	003-0825-00	$3.10
F2	Adjustment tool metal blade (except P6055/P6202A)	003-1364-00	$1.50
F3	Adjustment tool plastic blade (except P6055/P6202A)	003-1364-01	$.60
F4	Adjustment tool P6055	003-0675-00	$2.40
F5	Adjustment tool P6202A	003-0675-01	$2.50



Code	Description	Part No.	Price
G6	Probe tip cap lead for all miniature size probe tips		
	3 inches	175-0849-00	$8.25
	6 inches	175-0849-01	$7.50
G7	Clip-on for P6048/P6053B/P6055/P6062B/P6063B/P600X/P610XA families/P6125/P6148A/P6149		
	3 inches	175-0263-01	$2.50
	5 inches	175-0124-01	$2.50
	12 inches	175-0125-01	$2.80
G8	Clip-on for P6202A/P6420/S-3A 6 inches	175-1017-00	$4.25
G9	Low impedance contact for P613X/P6230 families 2 inches	195-4240-00	$2.45
G10	Alligator clip for P612X/P613X/P6230 families 8 inches	195-1870-00	$7.00
G11	Slip on gound lead for P6134/P6135/P6231 6 inches	196-3113-00	$6.25



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MODULAR PROBE REPLACEMENT SUBASSEMBLIES

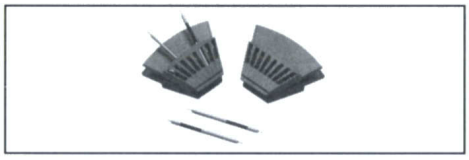
Probe	Length (m)	Connector/Comp Box		Probe Cable		Probe Head		Probe Tip/Hybrid Tip	
P6101	1	103-0189-00	$23.00	174-0076-00	$17.00	206-0223-02	$20.00	206-0191-03*1	$21.00
	2	103-0189-00	$23.00	174-0077-00	$19.00	206-0223-02	$20.00	206-0191-03*1	$21.00
	3	103-0189-00	$23.00	174-0078-00	$21.00	206-0223-02	$20.00	206-0191-03*1	$21.00
P6101A	1	103-0189-00	$23.00	174-0076-00	$17.00	206-0223-02	$20.00	206-0191-03*1	$21.00
	2	103-0189-00	$23.00	175-0077-00	$19.00	206-0223-02	$20.00	206-0191-03*1	$21.00
	3	103-0189-00	$23.00	174-0078-00	$21.00	206-0223-02	$20.00	206-0191-03*1	$21.00
P6102A	2	206-0352-00	$45.00	174-0077-00	$19.00	206-0302-00	$22.00	206-0338-01*2	$25.00
P6103*5	1	NA		174-0394-00	$18.00	206-0365-00	$25.00	131-3723-01*7	$6.00
	2	NA		174-0395-00	$20.00	206-0361-00	$25.00	131-3723-01	$6.00
	3	NA		174-0396-00	$22.00	206-0367-00	$25.00	131-3723-01	$6.00
P6104	1	040-1162-00	$55.00	174-0076-00	$17.00	040-1162-00	$55.00	206-0191-03*1	$21.00
P6104A	1	206-0332-00	$53.00	174-0076-00	$17.00	206-0303-00	$20.00	206-0336-01*2	$25.00
P6105	1	040-1163-00	$55.00	174-0076-00	$17.00	040-1163-00	$55.00	206-0191-03*1	$21.00
	2	040-1164-00	$55.00	174-0077-00	$19.00	040-1164-00	$55.00	206-0191-03*1	$21.00
	3	040-1165-00	$55.00	174-0078-00	$21.00	040-1165-00	$55.00	206-0191-03*1	$21.00
P6105A	1	206-0331-00	$60.00	174-0076-00	$17.00	206-0328-00	$22.00	206-0336-01*2	$25.00
	2	206-0334-00	$60.00	174-0077-00	$19.00	206-0301-00	$22.00	206-0337-01*2	$25.00
	3	206-0320-02	$60.00	174-0078-00	$21.00	206-0302-00	$22.00	206-0338-01*2	$25.00
P6106	1	040-1166-00	$60.00	174-0076-00	$17.00	040-1166-00	$60.00	206-0191-03*1	$21.00
	2	040-1167-00	$60.00	174-0077-00	$19.00	040-1167-00	$60.00	206-0191-03*1	$21.00
	3	040-1168-00	$60.00	174-0078-00	$21.00	040-1168-00	$60.00	206-0191-03*1	$21.00
P6106A	1	206-0313-01	$95.00	174-0076-00	$17.00	206-0328-00	$22.00	206-0336-01*2	$25.00
	2	206-0319-01	$95.00	174-0077-00	$19.00	206-0301-00	$22.00	206-0337-01*2	$25.00
	3	206-0320-01	$90.00	174-0078-00	$21.00	206-0302-00	$22.00	206-0338-01*2	$25.00
P6107	2	040-1173-00	$55.00	174-0077-00	$19.00	040-1173-00	$55.00	206-0191-03*1	$21.00
P6107A	2	206-0247-02	$62.00	174-0077-00	$19.00	206-0217-02	$22.00	206-0339-02*2*4	$29.00
P6108	1	040-1169-00	$55.00	174-0076-00	$17.00	040-1169-00	$55.00	206-0191-03*1	$21.00
	2	040-1170-00	$55.00	174-0077-00	$19.00	040-1170-00	$55.00	206-0191-03*1	$21.00
	3	040-1171-00	$55.00	174-0078-00	$21.00	040-1171-00	$55.00	206-0191-03*1	$21.00
P6108A	1	206-0332-01	$53.00	174-0076-00	$17.00	206-0303-00	$20.00	206-0336-01*2	$25.00
	2	206-0318-02	$53.00	174-0077-00	$19.00	206-0304-00	$20.00	206-0337-01*2	$25.00
	3	206-0333-00	$53.00	174-0078-00	$21.00	206-0305-00	$20.00	206-0338-01*2	$25.00
P6109*5	1.5	NA		174-0714-00*4	$19.00	206-0372-00	$35.00	131-3723-01*7	$6.00
	2	NA		174-0715-00*4	$21.00	206-0360-00	$35.00	131-3723-01	$6.00
	3	NA		174-0393-00	$23.00	206-0366-00	$35.00	131-3723-01	$6.00
P6121	1.5	206-0311-00	$60.00	174-0069-00	$17.00	206-0323-00	$25.00	206-0341-01*2	$29.00
P6122	1.5	206-0312-00	$50.00	174-0069-00	$17.00	206-0324-00	$21.75	206-0342-01*2	$25.00
	2	206-0318-00	$50.00	174-0070-00	$19.00	206-0325-00	$21.00	206-0343-01*2	$25.00
	3	206-0318-01	$50.00	174-0071-00	$21.00	206-0326-00	$21.00	206-0344-01*2	$25.00
P6125	1.5	206-0335-00	$45.00	174-0069-00	$17.00	206-0256-02	$35.00	131-2509-04*1	$50.00
P6130*6	1.5	206-0313-00	$85.00	174-0072-00	$22.00	206-0270-10	$12.00	206-0270-10*3	$12.00
	2	206-0319-00	$85.00	174-0073-00	$26.00	206-0270-12	$12.00	206-0270-12*3	$12.00
	3	206-0320-00	$85.00	174-0074-00	$31.00	206-0270-11	$12.00	206-0270-11*3	$12.00
P6131*6	1.3	206-0314-00	$90.00	174-0075-00	$22.00	206-0265-10	$12.00	206-0265-10*3	$12.00
	2	206-0321-00	$90.00	174-0073-00	$26.00	206-0265-12	$12.00	206-0265-12*3	$12.00
	3	206-0322-00	$90.00	174-0074-00	$31.00	206-0265-11	$12.00	206-0265-11*3	$12.00
P6133*6	1.3	206-0349-00	$70.00	174-0075-00	$22.00	206-0265-10	$12.00	206-0265-10*3	$12.00
	2	206-0350-00	$70.00	174-0073-00	$26.00	206-0265-12	$12.00	206-0265-12*3	$12.00
	3	206-0351-00	$70.00	174-0074-00	$31.00	206-0265-11	$12.00	206-0265-11*3	$12.00
P6134	1.5	206-0363-00	$90.00	174-0245-00	$22.00	206-0265-13	$12.00	206-0265-13	$12.00
P6136*6	1.3	206-0359-00	$95.00	174-0261-00	$22.00	206-0265-10	$12.00	206-0265-10	$12.00
P6148	2	040-1172-00	$55.00	174-0077-00	$19.00	040-1172-00	$55.00	206-0191-03*1	$21.00
P6148A	2	206-0288-02	$55.00	174-0077-00	$19.00	206-0217-02	$22.00	206-0339-03*2*4	$29.00
P6149	2	040-1174-00	$55.00	174-0077-00	$19.00	040-1174-00	$55.00	206-0191-03*1	$21.00
P6149A	2	206-0255-02	$55.00	174-0077-00	$19.00	206-0217-02	$22.00	206-0339-03*2*4	

*1 *Probe tips in packages of ten.*
*2 *Probe hybrid tip assemblies in packages of five.*
*3 *Probe hybrid tip assembly in quantities of one.*
*4 *Contact your local Sales Engineer for information.*
*5 *Probe sleeve cover for compensation adjustment is P/N 200-3342-00.*
*6 *Probe body shield for P6130, P6131, P6133, and P6136 is P/N 204-0925-01.*
*7 *Package of 5 tips.*

TEST LEADS

Test Lead, Black, 4 ft (T2)	012-0425-00	$12.75
Test Lead, Red, 4 ft (T1)	012-0426-00	$23.00
Test Lead, Black, 4 ft (T1)	012-0426-01	$23.00
Test Lead set includes: 012-0425-00, 012-0426-00, 013-0107-05	012-0427-00	$29.00

KLIPKIT



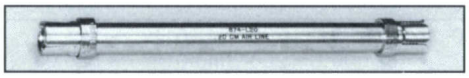
The P6130/P6131/P6230 are used directly, other probes must use the supplied pins and attach via a retractable hook tip. Up to 16-pin DIP can be connected. Four supplied pins make signals accessible at the top of the KLIPKIT, or invert the pins for pin signal connection to a common connection strap inside the clip. Two IC clips, 4 signal ground pins and information sheet included.

KLIPKIT	013-0197-00	$46.00

IC CLIP

16-pin DIP, clothes pin style	003-0709-00	$14.75
24-pin DIP, clothes pin style	003-0823-00	$34.00
40-pin DIP, clothes pin style	003-0801-00	$50.00

50 Ω AIR LINE



The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50 Ω Air Line	017-0084-00	$220.00

PATCH CORDS

BNC to BNC, 18 in.		
Red	012-0087-00	$16.25
Black	012-0086-00	$8.25
BNC to banana plug-jack, 18 in.		
Red	012-0091-00	$8.25
Black	012-0090-00	$8.25
Banana plug-jack to banana plug-jack, 18 in.		
Red	012-0031-00	$8.25
Black	012-0039-00	$9.25
Pin-jack to pin-jack, 0.08 in. dia pin		
Red, 8 in.	012-0179-00	$4.25
Red, 18 in.	012-0180-00	$4.55
Black, 8 in.	012-0181-00	$4.50
Black, 18 in.	012-0182-00	$5.50

COAXIAL CABLES
BNC

50 Ω, 42 in.	012-0057-01	$18.50
75 Ω, 42 in.	012-0074-00	$19.00
93 Ω, 42 in.	012-0075-00	$33.00
50 Ω, 18 in.	012-0076-00	$17.50
50 Ω, 18 in. Male to Female	012-0104-00	$26.00
50 Ω ±1% Precision, 36 in.	012-0482-00	$28.00
BSM Female to BNC Male, 10 in. RG58	012-0128-00	$25.00
BSM Female to BNC Male, 18 in. RG58	012-0127-00	$30.00

COAXIAL GR 50 Ω

10 ns, RG58A/U	017-0501-00	$110.00
5 ns, RG213/U	017-0502-00	$200.00
1 ns, RG58A/U*1	017-0503-00	$95.00
2 ns, RG58A/U	017-0505-00	$150.00
5 ns, RG58A/U	017-0512-00	$115.00
10 in. RG213/U	017-0513-00	$95.00
20 in. RG213/U	017-0515-00	$105.00

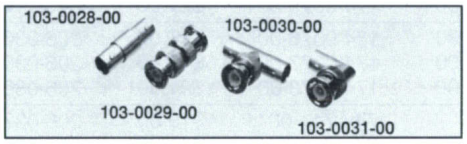
*1 *Connector on one end only.*

COAXIAL N 50 Ω

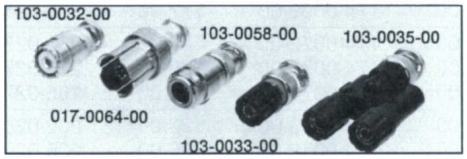
N Connectors, 6 ft	012-0114-00	$29.00

COAXIAL SMA (3 mm) 50 Ω

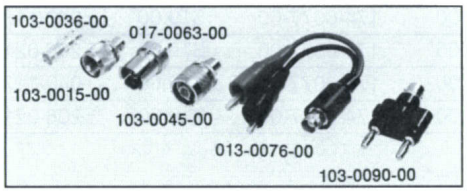
2 ns, Male to Female	015-1005-00	$120.00
5 ns, Male to Female	015-1006-00	$180.00
Semirigid, 500 ps, 4.5 in. male only	015-1015-00	$30.00
Semirigid, 750 ps, 1 ns	015-1017-00	$43.00
	015-1019-00	$150.00



BNC Female to BNC Female	103-0028-00	$6.75
BNC Male to BNC Male	103-0029-00	$8.00
BNC T	103-0030-00	$9.50
BNC Elbow Male to Female	103-0031-00	$8.75



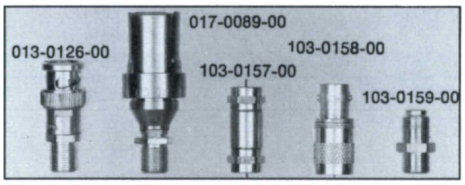
BNC Male to GR	017-0064-00	$100.00
BNC Male to UHF Female	103-0032-00	$6.50
BNC Male to Binding Post	103-0033-00	$6.25
BNC Male to Dual Binding Post	103-0035-00	$14.75
BNC Male to N Female	103-0058-00	$8.75



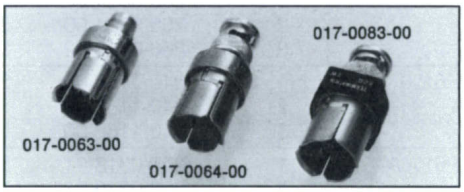
BNC Female to Clip Leads	013-0076-00	$40.00
BNC Female to GR	017-0063-00	$55.00

(Continued next column)

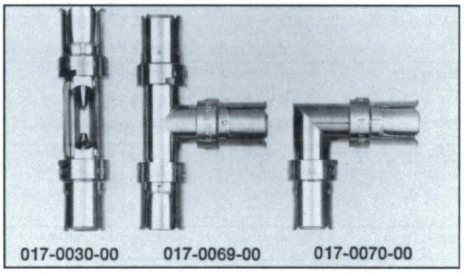
BNC Female to UHF Male	103-0015-00	$5.75
BNC Female to BSM Male	103-0036-00	$18.00
BNC Female to N Male	103-0045-00	$8.25
BNC Female to Dual Banana	103-0090-00	$9.50
BNC Female to EZ Ball	013-0076-01	$23.00



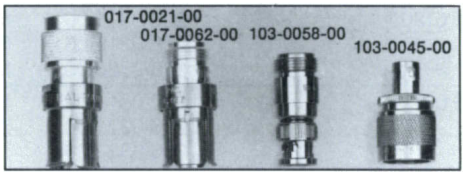
Female to BNC Male	013-0126-00	$18.75
"F" Female to GR	017-0089-00	$55.00
"F" Male to "F" Male	103-0157-00	$7.50
"F" Male to BNC Female	103-0158-00	$10.75
"F" Female to "F" Female	103-0159-00	$7.50



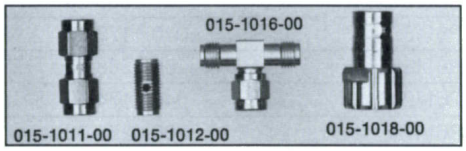
GR to BNC Female	017-0063-00	$55.00
GR to BNC Male	017-0064-00	$100.00
50 Ω termination, thru-line (GR to BNC Male)	017-0083-00	$100.00



GR Insertion Unit	017-0030-00	$95.00
GR T	017-0069-00	$165.00
GR Elbow	017-0070-00	$165.00

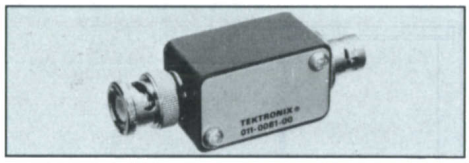


N Male to GR	017-0021-00	$65.00
N Female to GR	017-0062-00	$70.00
N Male to BNC Female	103-0045-00	$8.25
N Female to BNC Male	103-0058-00	$8.75



SMA Male to Male	015-1011-00	$25.00
SMA Female to Female	015-1012-00	$11.00
SMA T	015-1016-00	$41.00
SMA Male to BNC Female	015-1018-00	$10.25

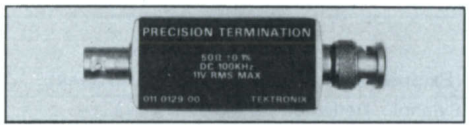
Minimum acceptable order is $25.00.



ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing 011-0081-00 $49.00



ATTENUATORS—TERMINATIONS
BNC 50 Ω

50 Ω±0.1% precision feedthrough termination (dc –100 kHz, 11 V RMS maximum)	011-0129-00	$120.00
50 Ω feedthrough termination*1	011-0049-01	$32.00
50 Ω 10X (20 dB) attenuator*2	011-0059-02	$45.00
50 Ω 5X (14 dB) attenuator*2	011-0060-02	$44.00
50 Ω (6 dB) attenuator*2	011-0069-02	$45.00
50 Ω 2.5X (8 dB) attenuator*2	011-0076-02	$44.00
50 Ω feedthrough termination (5 W)*3	011-0099-00	$55.00

VSWR

*1 *<1.1 dc –250 MHz and <1.2 dc –500 MHz.*
*2 *<1.1 dc –1.0 GHz and <1.2 dc –2.0 GHz.*
*3 *1.1 dc –100 MHz.*

Characteristics—DC resistance is 50 Ω ±1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

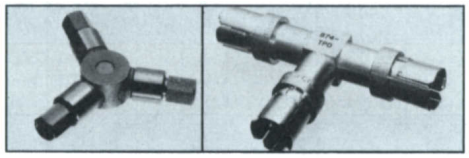
75 Ω feedthrough termination	011-0055-01	$32.00
93 Ω feedthrough termination	011-0056-01	$32.00
50 Ω to 75 Ω minimum loss attenuator	011-0057-01	$38.00
50 Ω to 93 Ω minimum loss attenuator	011-0058-01	$34.00
75 Ω 10X attenuator	011-0061-00	$35.00
93 Ω 10X attenuator	011-0062-00	$36.00
600 Ω feedthrough termination (1 W, dc to 1 MHz)	011-0092-00	$34.00
75 Ω to 50 Ω minimum loss attenuator (ac coupled)	011-0112-00	$60.00

Characteristics—Accuracy of indicated attenuation ratio is ±2% at dc. Power rating of attenuators is ½ W and terminations 1 W. Voltage standing wave ratio (VSWR) not specified.

GR 50 Ω

50 Ω 10X attenuator	017-0078-00	$345.00
50 Ω 5X attenuator	017-0079-00	$300.00
50 Ω 2X attenuator	017-0080-00	$235.00
50 Ω termination, end-line	017-0081-00	$305.00

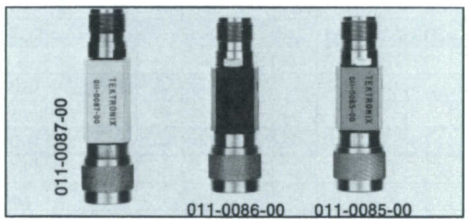
Characteristics—Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (VSWR) is <1.1 up to 1 GHz. Power rating is 1 W.



50 Ω POWER DIVIDERS

Designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Maximum VSWR on the 015-1014-00 is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

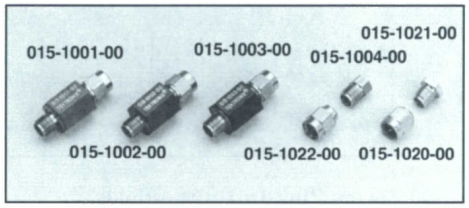
Power Divider SMA (3 mm)	015-1014-00	$255.00
Power Divider GR	017-0082-00	$800.00



N 50 Ω

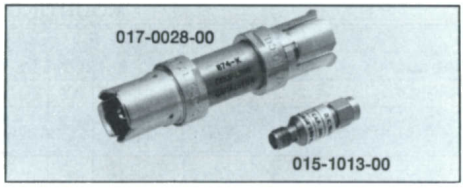
10 dB attenuator	011-0085-00	$90.00
20 dB attenuator	011-0086-00	$90.00
40 dB attenuator	011-0087-00	$115.00

Characteristics—Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω ±1.0 dB.



SMA (3 mm) 50 Ω

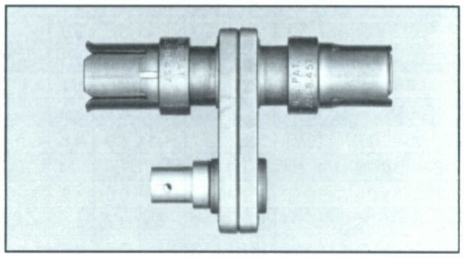
50 Ω 2X attenuator	015-1001-00	$150.00
50 Ω 5X attenuator	015-1002-00	$150.00
50 Ω 10X attenuator	015-1003-00	$155.00
50 Ω termination Female	015-1004-00	$75.00
Short-Circuit terminations—		
(Male)	015-1020-00	$21.00
(Female)	015-1021-00	$27.00
50 Ω termination Male	015-1022-00	$40.00



50 Ω COUPLING CAPACITORS

The coupling capacitor is a short length of coaxial line with a disk capacitor (4700 pF ±20%) in series with the inner conductor. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 200 V (015-1013-00), 500 V (017-0028-00).

Coupling Capacitor SMA (3 mm)	015-1013-00	$230.00
Coupling Capacitor GR	017-0028-00	$125.00



CT-3 Signal Pickoff

Design for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

Sensitivity—10% of the voltage under test, into a 50 Ω load.
Decay Time Constant—4.5 μs at 0 dc current.
Rise Time—<0.4 ns.
Frequency Response—50 kHz to 875 MHz at 0 dc current.
Insertion Impedance—With 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 Ω termination.
VSWR—<1.2 at 1.5 GHz.
Voltage Rating—At 0 V dc is 25 V RMS. 1 kV pulse peak. The V's product is 100 Vμs. If exceeded, the L/R decay will decay rapidly toward zero.

Order 017-0061-00 $195.00

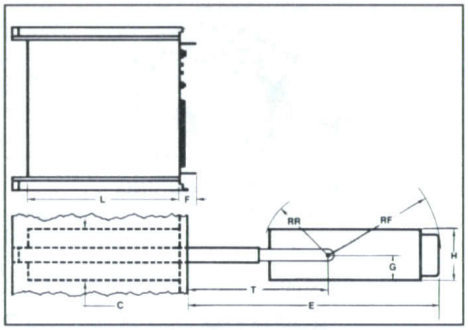
SMA Characteristics

	DC to 12.40 GHz		12.41 to 18.00 GHz		Power
	Attenuation		Attenuation		
	Accuracy	VSWR	Accuracy	VSWR	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	±0.75 dB	1.40±1.00 dB	1.60	1.0 W	

MOUNTING ACCESSORIES

	H		L		F		G		E		RF		RR		T		C	
Product	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**
R485*1	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	49.0	10.9	27.7	7.9	20.1	9.3	23.6	6.8	17.3
R5100 R5400*1	5.3	13.5	19.0	48.3	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
R5223	7.0	17.8	20.8	52.9	1.3	3.3	—	—	—	—	—	—	—	—	—	—	7.0	17.8
R7103	7.0	17.8	27.7	70.4	1.5	3.8	—	—	29.0	73.7	—	—	—	—	—	—	7.0	17.8
R7704*1	7.0	17.8	22.4	56.9	2.3	5.8	1.8	4.6	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313*1 R7603*1 R7613*1 R7623*1	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	5.3	13.5
R7844*1	7.0	17.8	24.8	63.0	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
R7903*1	5.3	13.5	22.8	57.9	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	17.
R7912*	5.3	13.5	26.9	68.3	1.8	4.6	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	—	—	30.7	78.0	—	—	—	—	—	—	6.9	17.5
RTM506	5.25	1	18.9	48.0	1.82	4.7	—	—	—	—	—	—	—	—	—	—	5.25	13.3
016-0015-00	5.1	13.0	16.3	41.4	1.8	4.5	—	—	—	—	—	—	—	—	—	—	—	—
016-0115-05	5.3	13.5	16.3	41.4	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
016-0466-00	5.1	13.0	16.3	41.4	1.8	4.5	—	—	—	—	—	—	—	—	—	—	—	—
016-0468-00	5.2	13.3	14.9	37.8	2.0	5.1	—	—	—	—	—	—	—	—	—	—	—	—
016-0675-00*1	8.8	22.4	19.7	50.1	1.5	3.9	3.5	8.9	24.3	61.6	—	—	11.9	30.1	13.3	33.8	8.5	21.6
016-0676-00*1	7.0	17.8	19.7	50.1	1.9	4.8	3.5	8.9	24.3	61.6	11.1	28.2	11.2	28.4	13.3	33.8	6.9	17.5
016-0691-01*1	7.0	17.8	18.3	46.5	1.5	3.9	3.5	8.9	20.4	51.9	11.8	30.0	—	—	9.5	24.1	6.6	16.7
040-0551-01	14.0	35.6	22.4	56.9	0.6	1.5	—	—	30.9	78.5	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
040-0601-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.25	13.3
040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
040-0624-01	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0126-03	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	6.6	16.8

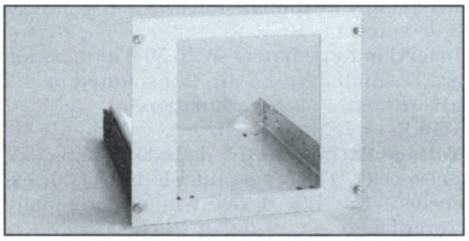
*1 *These instruments mount with sliding tracks to a standard 19-inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.*



DIMENSIONS
(Exclusive of Plug-In Units and Probes)

Symbol	Definition
H	Height of front panel
L	Rack front to rearmost permanent fixture excluding cables
F	Back of front panel to foremost protrusion
G	Bottom of front panel to horizontal plane of rotation
E	Maximum forward clearance with instrument out and horizontal
RF	Front radius of rotation
RR	Rear radius of rotation
T	Rack front to pivot point
C	Cabinet height

RACK ADAPTERS



For rackmounting 7000 Series oscilloscopes in a standard 19 in. wide rack. Rack adapter includes slide-out assemblies. 7000 Series mask finish is light gray.

7704A/7104/7834/7854—Rack height is 15.75 in., rack depth is 21.38 in., shipping weight is ≈41 lb. Order 040 0611-01 $525

455/465M—Includes cradle mount, rack height 7 in., rack depth 18.75 in. Order 040-0825-01 $565

2445A/2465A—Order 016-0691-01*1

2335—Order 016-0468-00 $315

2213A/2215A/2235—Order 016-0466-00 $130

2236—Order 016-0015-00 $290

464/466—Order 016-0676-00 $450

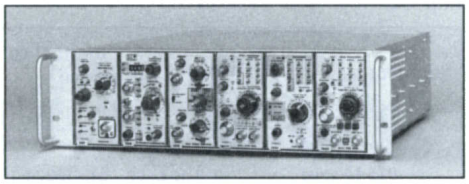
485—Order 016-0558-00 $530

434—Order 016-0272-00 $300

468—Order 016-0675-00 $670

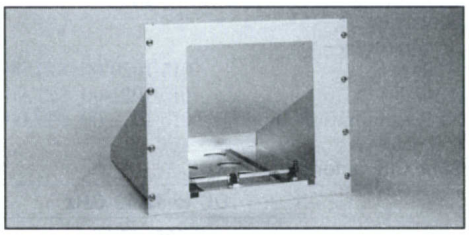
*1 *Contact your local Sales Office.*

STORAGE CABINETS



7000 Series Plug-In Units—Holds 6 plug-in units, for mounting in a 19 in. rack, 5.25 in. high. Order 437-0126-03 $1,055

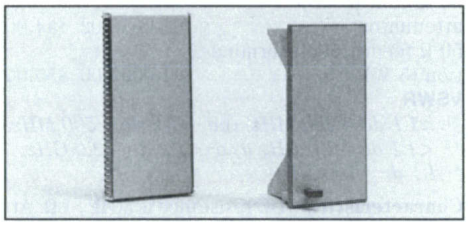
CRADLE MOUNTS



For rackmounting 7000 Series cabinet-type oscilloscopes in a standard 19 in. wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 7000 Series mask finish is light gray.

7704A—Rack height is 22 in. shipping weight is ≈16 lb. Order 040-0560-00 $535

BLANK PANEL



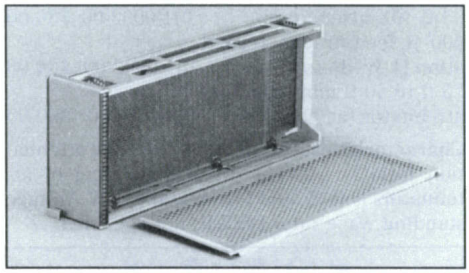
Blank Panel—When operating the 5000/7000 Series mainframes or the TM 500/TM 5000 Series mainframes with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

7000 Series—Order 016-0155-00 $60

5000 Series—Order 016-0452-00 $25

TM 500/TM 5000 Series—Order 016-0195-03 $33

BLANK PLUG-IN CHASSIS



Blank Plug-In Chassis—Available for all Tektronix mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

7000 Series—Order 040-0553-03 $175

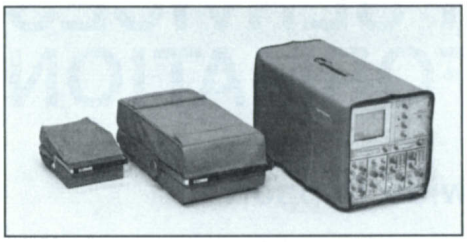
5000 Series—Order 040-0818-03 $130

TM 500 Series—Order 040-0652-05 $115

560 Series—Order 040-0245-00 $180

Minimum acceptable order is $25.00.

OSCILLOSCOPE PROTECTIVE COVERS



The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500/5000/7000 Series have clear vinyl frontal areas.

PROTECTIVE COVERS

Instrument	Part Number	Price
200 Series	016-0512-00	$17.50
323/324/1401A/ 1401A-1/1501	016-0112-00	$8.75
314/335	016-0612-00	$80.00
326	016-0532-00	$49.00
453A/454A/491	016-0074-01	$18.00
434/464/466	016-0365-00	$27.00
465/465B/475/485	016-0554-00	$19.25
5000 Series	016-0544-00	$19.25
7300/7400/7600 Series	016-0192-01	$20.00
7704A/7900	016-0531-00	$15.00

PLUG-IN UNIT CARRYING CASES

3-Wide—For 7L14/7L5 Option 25/ 7D20/7L18. Order 016-0626-00 $390

2-Wide—For 7L12/7L5. Order 016-0625-00 $330

CRT MESH FILTERS

The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions. A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low intensity displays in room light or other bright surroundings.

The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

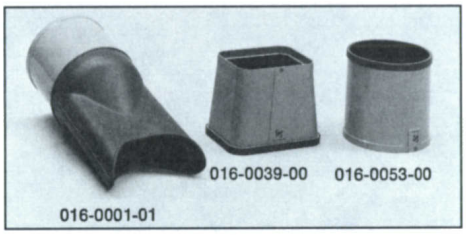
Instrument*1	Part Number	Price
314/326/335	378-0063-00	$23
432/434	378-0682-00	$55
422/491/453A/454A/485	378-0648-00	$60
465/465B/475/ 464/466/434	378-0726-01	$90
7400/7603	378-0696-00	$70
7100/7500/7700/ 7800/7900 Series/ 7613/7623/7633	378-0603-00	$75

*1 *For both cabinet & rackmount instruments.*

VIEWING ACCESSORIES

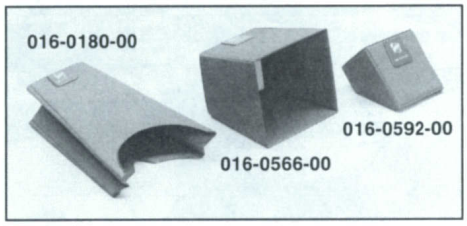
The viewing accessories normally mount on the oscilloscope graticule cover. Some may fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tek Sales Engineer for bezel-viewer compatibility.

Folding Viewing Hoods—
(576) Order 016-0259-00 $25
(577/5000/7000 Series)
Order 016-0260-00 $27
(326/314/335/SC 502/SC 503/SC 504)
Not pictured. Order 016-0297-00 $2.10



Polarized Viewers—For Tek older 5-inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.
(Rectangular)—Order 016-0039-00 $95
Plastic Round—Order 016-0053-00 $42

Viewing Hood—For Tek older 5-inch round oscilloscopes. Includes molded rubber eyepiece & separate tubular light shield. Order 016-0001-01 $200



Collapsible Viewing Hoods—For oscilloscopes with rectangular CRTs. Blue vinyl, folds flat for storage.
(422/453A/454A/485/491)
Order 016-0274-00 $19
(464/466/455/465/465B/475/ 2200 Series/2445A/2465A)
Order 016-0592-00 $14.25

Folding Binocular Viewing Hoods—
(434/455/464/466/465B/475/475A/ 2200 Series) Order 016-0566-00 $19
(422/453A/454A/485/491)
Order 016-0082-0 $21

Polarized Collapsible Viewing Hoods—To reduce reflections and glare under high ambient light.
(432/434/455/465/465B/475/464/466/ 2445A/2455A/2465A)
Order 016-0180-00 $60

Viewing Hoods—Molded gray polystyrene with polyurethane eyepiece.
(576) Order 016-0153-00 $55
(5000/7000 Series/601/602/603/ 604/528/577) Order 016-0154 00 $43

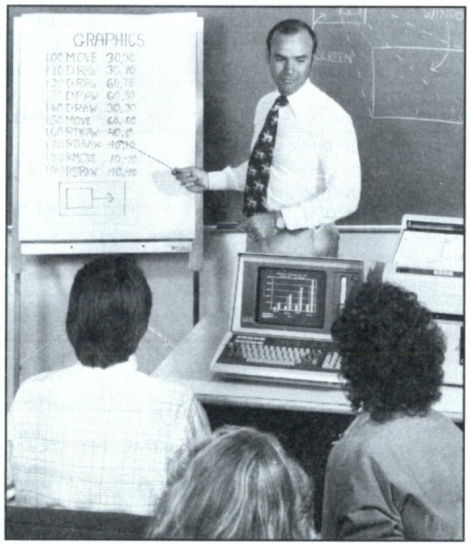
CATHODE-RAY TUBE LIGHT FILTERS

Instrument*1	Color	Part Number	Price
200 Series	Blue	378-0691-00	$1.85
314/335	Blue	378-2016-01	$1.85
434	Blue	378-0678-01	$2.30
455/465M	Blue	337-2122-00	$6.00
465/465B/ 475, 464/466	Blue	337-1674-00	$7.25
	Clear	337-1674-01	$6.50
	Smoke-gray filter	337-1674-07	$6.50
540/550 Series 565/575	Smoke-gray*2	378-0567-00	$14.25
	Green	378-0568-00	$11.50
	Blue	378-0569-00	$11.50
	Amber	378-0570-00	$14.25
576	Blue*2	378-0616-00	$6.00
603/604	Clear (603*2)	337-1440-00	$3.75
	Green	337-1440-01	$3.75
	Amber	337-1440-02	$3.50
	Blue	337-1440-03	$3.50
	Gray	337-1440-04	$4.50
	Graticule (8×10 div)	331-0303-00	$15.00
605/606/ 607	Blue	337-1674-00	$7.25
	Graticule	337-1674-10	$10.00
	Clear Shield	337-1674-13	$13.50
	Gray*2	337-1674-06	$5.00
	Graticule (8×10 div)	331-0391-00	$9.00
608	Amber	378-0704-00	$10.00
	Graticule*2	337-2126-02	$10.00
2200 Series	Blue*2	337-2775-00	$3.80
	Clear TV Graticule	337-2775-01	$1.95
2300 Series	Blue Implosion Shield*2	337-2760-00	$1.65
	Clear Implosion Shield*2	337-2781-00	$4.40
2400 Series	Blue*2	378-0199-03	$2.30
	Clear Implosion Shield*2	378-0208-00	$1.50
5100 & 5400 Series (except 5441)	Clear	337-1440-00	$3.75
	Green	337-1440-01	$3.75
	Amber	337-1440-02	$3.50
	Blue	337-1440-03	$3.50
	Gray	337-1440-04	$4.50
5441	Clear*2	337-1674-01	$6.50
	Gray	337-1674-06	$5.00
	Graticule (8×10 div)	331-0391-00	$9.00
7603	Blue	378-0684-00	$7.00
	Amber	378-0684-01	$7.00
	Gray	378-0684-02	$7.00
	Green	378-0684-03	$10.00
	Spectrum Analyzer Graticule	337-1439-01	$8.50
	Blue Implosion Shield*2	337-1700-01	$6.00
	Clear Implosion Shield	337-1700-04	$5.50
7613/762 3/7623A/ 7633	Spectrum Analyzer Graticule	378-0625-07	$14.50
	Green (UV)	378-0625-08	$5.00
7844/7313	Blue*2	378-0625-00	$6.50
7700 Series/ 7613/ 7623/7100 Series/ 7900 Series	Amber	378-0625-01	$9.50
	Gray	378-0625-02	$6.75
	Green	378-0625-03	$5.00
	Gray TV Graticule NTSC	378-0625-06	$12.00
	Clear Shield Spectrum Analyzer Graticule	337-1159-02	$8.50

*1 *For both cabinet and rackmount instruments unless rackmount version is listed.*
*2 *Standard filter supplied with instrument.*

CUSTOMER SERVICES AND INFORMATION

Tektronix Means . . . Fast, Flexible Worldwide Support



The people behind the product are friendly and ready to help you.

Get sales information and assistance to evaluate and order the products you want.

Ask for a Customer Service Representative the first time you contact Tektronix. The CSR can give you information on products and the names of the Sales Engineers assigned to serve your product interest. Tektronix Sales Engineers will respond to your technical and business inquiries.

Sales Engineers can give you information on dozens of products, so that you can select the one model best suited to your present and future applications, and will be happy to arrange a demonstration of that product.

Your Customer Service Representative or Sales Engineer can provide you with information on prices, terms, delivery dates, shipping estimates and best means of shipping.

Customer-site installations are thorough.

Tektronix provides on-site installations for most computer graphics products and most Tek-configured systems for computer graphics, semiconductor test, microprocessor development, and acquisition/processing. The Tektronix service specialist will make sure your equipment is set up properly with all functions operating to specifications, and will walk you through the basics of its performance.

Training and assistance gets users up to speed, fast.

Your Tektronix product is most useful to you when you're thoroughly familiar with it.

CONTENTS

Sales Information and Assistance . 537
User Assistance 537
Warranty-Plus
Service Plans 538-541
Product Characteristics 543
Terms of Sale 543
Warranty Statement 543
OEM Information 545
Sales and Service
Offices . . . . . Inside Back Cover

Tektronix offers formal classes and self-study aides. Ask your Sales Engineer for details about Customer Training.

Test and Measurement Workshops

Tektronix instruments and programmable instrument systems represent the upper limits of productivity potential. Tektronix has designed workshops to help enhance your understanding of the capabilities of your equipment.

Customer Training Workshops naturally complement the Tektronix commitment to help you achieve optimum utilization of your equipment—A commitment that begins with engineering excellence and continues through training—helping you to develop new and more productive applications fast!

These fast-paced courses, conducted at key locations throughout the U.S., combine classroom lectures with supervised, hands-on laboratory sessions. Participants receive manuals and workbooks containing detailed course notes and lab exercises.

If you are interested in registering for one of these workshops or would like more information on a particular workshop, call instrument group customer training at (503) 629-1017 or write:

Tektronix, Inc.
IG Customer Training
P.O. Box 4600 M/S 94-953
Beaverton, Oregon 97076-4600

For your convenience, Tektronix also offers private workshops conducted at your company. Call us for more information.

Tektronix Service and Support

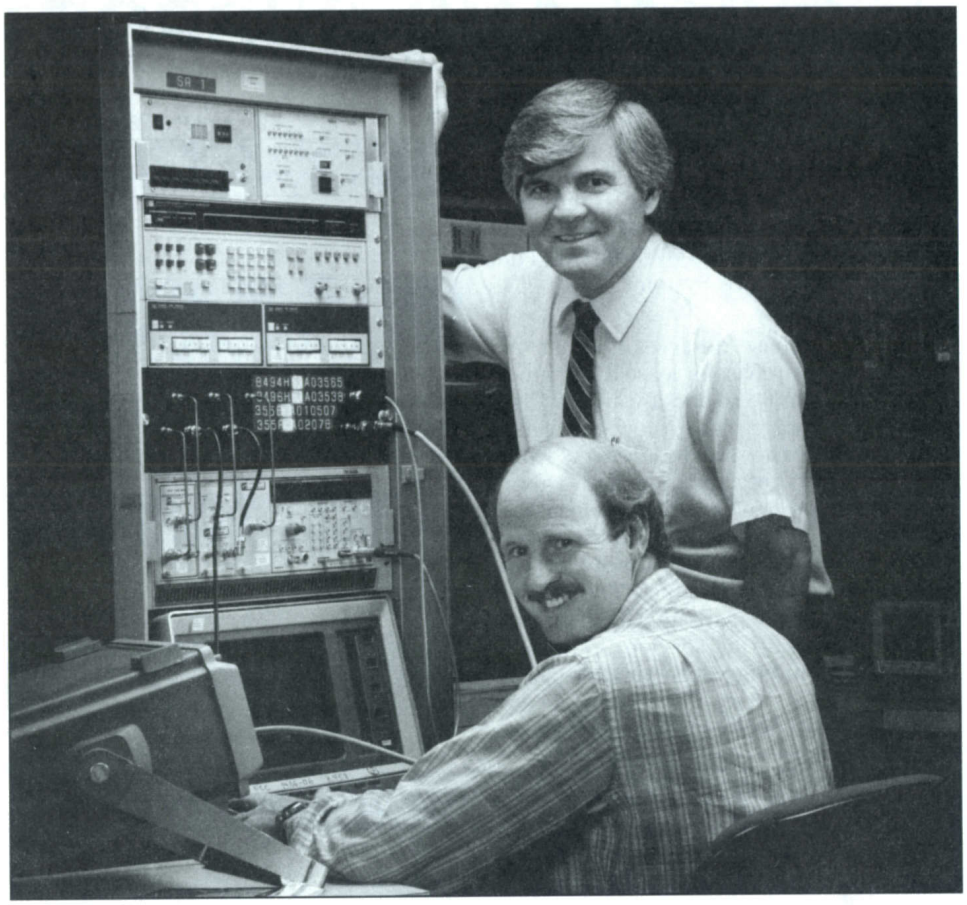
With every Tek product, you receive the backing of our worldwide service organization. Expert service and prompt turnaround are available through over fifty service locations in the United States and in over 60 countries

When it comes to servicing Tek products, who knows the products better than Tektronix factory trained technicians? You receive the benefit of our service specialists, trained and experienced in servicing Tektronix products. And your equipment will always receive the latest Tek service updates when a Tek service specialist is doing the job.

We have over $20 million in inventory of Tek parts, modules and assemblies at our service centers. This helps guarantee quick response and turnaround time.

You also have peace of mind that the service your products receive is from the undisputed experts in Tektronix products, Tek personnel themselves.

We use our service experience and your comments to improve our products and service. And we listen. What you tell us today influences directly our service offerings and the design of tomorrow's family of products. This helps us ensure you always get the products and service you need and can count on.



Continuous Support

Our service offerings cover the full range of needs and service levels you may require, from product purchase until out of production and beyond. It is truly long term product support for your Tek products.

Warranty

Support starts with a comprehensive Warranty on every new serialized product. Depending on the product, Warranty periods range from three months to three years.

Warranty-Plus

At the time you purchase or lease a Tek product, you can choose to add a warranty-like extended coverage plan. A small, one-time-only fee with the product purchase covers your costs for the life of the agreement. You can save money immediately by limiting your future service costs at the time you purchase or lease Tek products. The cost of our *Warranty-Plus* plans are the most cost effective long-term service plans available. Some *Warranty-Plus* plans cost even less than one on-site service call or a calibration and repair.

Annual Support Agreements

After *Warranty-Plus*, Annual Support Agreements are available to help you continue managing and controlling equipment costs and maintenance. There are many options to choose from that guarantee you receive the service and attention your situation requires.

Additional Services

Other service offerings include "Per-incident", Firm Price, Self-maintenance support, Installation, and Time-and-Material services. As with any Tek Service, your product always receives the quickest response and highest quality workmanship.

Long-Term Support

Our long-term Support Program ensures service availability for discontinued products up to nine years after production has ceased. Obsolete products will be serviced if the necessary parts are available.

Detailed explanations of available service programs are on the following pages. Read on and find the service offering that suits your needs the best. Then for further details call the Tektronix Service Office near you. Phone numbers for the Tektronix Service Center nearest you can be found in the back of this catalog.

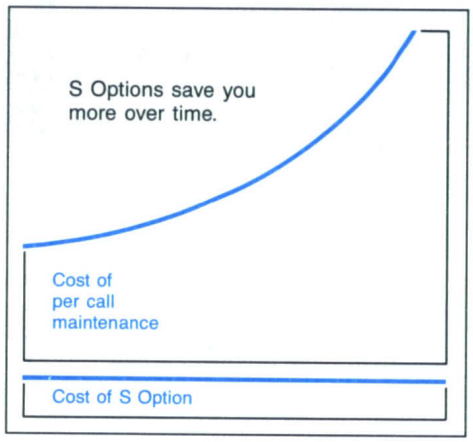
Tek Service: Keep a good thing going.

INFORMATION DISPLAY SERVICE AND SUPPORT

Tektronix offers fast on-site service and a variety of service plans for selected computer-based products, systems, and peripherals. This includes Computer Graphics and Microcomputer/CASE Products, Intelligent Graphics Workstations, and Artificial Intelligence Systems.

Warranty-Plus

One good purchase deserves another. At the time you purchase or lease a Tek product you can choose to add a warranty-like extended coverage plan. A low, one-time-only fee with the purchase covers your costs for the life of the agreement. Quantity discounts apply for further savings. You save money immediately by limiting your future service costs at the time you purchase or lease a Tek product. The cost of our *Warranty-Plus* plans are the most cost effective long-term service contracts available including even maintenance agreements. *Warranty-Plus* plan costs are typically less than one on-site service call.



Warranty-Plus—On-Site Service

For Tek Design & Graphic System products, we offer On-Site service options. These On-Site service options cover all labor, parts, materials and modules needed for preventive and remedial maintenance, as well as travel to your site. Customer-site service is performed during normal business hours at the customer's site within eight work-hours of notification if site is within 75 miles of service center.

Our eight work-hour response target means "one-day service" for virtually all customer sites in the contiguous U.S.A. during normal business days.

***Warranty-Plus* Service With Three-Month Product Warranty**

Product Warranty	9 months		12 months		12 months	Description
S1=3 months coverage plus	On-Site Coverage					Provides three months of product warranty and nine months of warranty-like on-site service.
S2=3 months coverage plus	On-Site Coverage	+	On-Site Coverage			Provides three months of product warranty and 21 months of warranty-like on-site service.
S3=3 months coverage plus	On-Site Coverage	+	On-Site Coverage	+	On-Site Coverage	Provides three months of product warranty and 33 months of warranty-like on-site service.

***Warranty-Plus* Service With One-Year Product Warranty**

Product Warranty		2nd Year		3rd Year	Description
S2=1 year coverage plus		On-Site Coverage			Provides one year product warranty, plus one year warranty-like on-site service.
S3=1 year coverage plus		On-Site Coverage	+	On-Site Coverage	Provides one year product warranty, plus two years warranty-like on-site service.

OEM *Warranty-Plus* Service With Six-Month Depot Product Warranty

OEM Product Warranty	1st Year		2nd Year		3rd Year	Description
S1=6 months depot coverage upgrades to	On-Site Coverage					Upgrades product warranty to one year on-site, transferrable to end user.
S2=6 months depot coverage upgrades to	On-Site Coverage	+	On-Site Coverage			Upgrades product warranty to two years on-site, transferrable to end user.
S3=6 months depot coverage upgrades to	On-Site Coverage	+	On-Site Coverage	+	On-Site Coverage	Upgrades product warranty to three years on-site, transferrable to end user.
S4=6 months depot coverage upgrades to	Three months On-Site Coverage					Upgrades product warranty to three months on-site, transferrable to end user.

Option S0

With this option we install, configure and integrate the Tek product to give you optimum performance. And this option is available with each new Field Upgrade Option you may install later.

Option S1, S2, S3

These agreements provide on-site coverage after the warranty period. They extend warranty-like coverage one (S1), two (S2), or three (S3) years. Preventive maintenance is provided to inspect, test, clean and adjust equipment such as mechanically-based copier, plotters and disk drives, Tek-configured systems, and CRTs to optimum performance. Reliability upgrades re-installed at no extra cost. This coverage includes all labor, parts, materials and modules needed as well as travel to your site.

Option S9

First year software upgrade coverage. This maintains Tek-licensed software at its highest revision level during your first year of ownership. It provides (1) appropriate media and documentation, (2) access to Tek's software development process, and (3) price protection against damage to original media. Specify Option S9 prior to product shipment.

For further information, call the nearest Tek Service Center to discuss your requirements. You'll find their number listed in the back of this catalog.

Warranty—Plus Conditions

International *Warranty-Plus* Options

Warranty-Plus is available in most countries, but service is only provided in the country where the product and plan are purchased. Response and turnaround times may be different than those provided in the United States. Please consult the Tektronix office, subsidiary, or approved distributor in your country.

Response and Turnaround Times

In the United States, *Warranty-Plus* S Option Customer-site service is performed during normal business hours at the customer's site within eight work-hours of notification, if the site is within 75 miles of a Tektronix Service Center. If not, response may be longer.

Customer Responsibilities

With Customer-site S Options, an end-user contact name, phone and location must be designated at the time of purchase.

Coverage Exclusions

Warranty-Plus Service purchased in the United States is only valid within the United States.

As you may expect, service under a *Warranty-Plus* Agreement does not apply if the failure is caused by misuse or inadequate care or maintenance, such as:

(a) Damage from repair attempts by non-Tektronix personnel
(b) Improper use or connection to incompatible equipment.
(c) Modification or integration that increases time or difficulty in servicing your product

AFTER WARRANTY & *WARRANTY-PLUS* Annual Customer-Site Support Agreements

After your Warranty or *Warranty-Plus* coverage expires, we continue to offer long-range service coverage through our Support Agreements. These Support Agreements provide you the ability to anticipate and manage your future equipment maintenance and related costs. And because the service is planned, our fastest support is reserved for agreement holders. All travel, parts and labor are covered. To maximize uptime, preventive maintenance is included to inspect, clean, and adjust your equipment to peak performance. Mandatory engineering upgrades are installed at no extra charge to enhance safety and reliability. The result is the highest long range performance at the least cost.

Customer Support Center

With *Warranty-Plus* or a maintenance agreement, the Customer Support Center (CSC) is available to assist you. The 1-800 number provides phone support for Design and Graphic products including hardware, software, and firmware. Call your Tek office or talk to your sales engineer about which products are covered by this new program.

Our CSC provides answers and technical assistance regarding applications and diagnostic questions. They also provide dispatch of a service technician if one is needed.

"Per-Call" Service

Dependable on-site service is also available at time and material rates plus travel expense. Repairs are warranted for 90 days.

Installation/Relocation Service

Tek offers expert moving and system set-up services at fixed-fee "Per-Call" rates.

Software Subscription Service

This provides current releases of Tektronix licensed software documentation. Call 1-800-835-6100 to order agreements on IGW, PLOT 10, AIM, and LoPro software. Call your Tek Sales Engineer for agreements on CASE software.

For the phone number to the Tektronix Service Center nearest you, consult the listings in the back of this catalog.

Tek Service: Keep a good thing going.

INSTRUMENTATION, TELEVISION, SPECTRUM ANALYZERS, AND COMMUNICATIONS PRODUCTS

Calibration and Repair Services

Our calibration and repair services provide the full spectrum of support for your Tek instrument. To maintain warranty-like coverage, choose *Warranty-Plus* with the calibration and repair option to suit your needs.

Beyond the Warranty or *Warranty-Plus* periods, Tektronix continues to support your equipment with a wide selection of Support Agreements, Per-Incident Calibration and Repair, and Special Services.

Warranty-Plus

One good purchase deserves another. At the time you purchase or lease a Tek product you can choose to add a warranty-like extension plan. A small, one-time-only fee at the time of product purchase covers your costs for the life of the agreement. You can save money immediately by limiting your future service costs at the time you purchase or lease a Tek product.

Warranty Plus plans provide the most cost-effective long-term service available. And some *Warranty-Plus* plans are even less than one Firm-Price calibration and repair. It is another way Tek service keeps your costs down and your instruments up. Refer to the *Warranty-Plus* tables on these two pages for instrumentation products with one or three year warranties. Note: ALL calibrations are NBS traceable.

Warranty-Plus Conditions

International *Warranty-Plus* Options

Warranty-Plus is available in most countries, but service is only provided in the country where the product and plan are purchased. Response and turnaround times may be different than those provided in the United States. Please consult the Tektronix subsidiary or approved distributor in your country.

Response and Turnaround Times

Warranty-Plus assures that your Instrumentation products receive top priority response. Contact your local Service Center for turnaround times that meet your business needs.

Customer Responsibilities

When products need servicing under M-Option coverage, it is the customer's responsibility to deliver or ship them to a designated Tektronix Service Center. Shipping charges to Tektronix must be paid by the customer. Return shipping is paid by Tektronix.

Coverage Exclusions

Warranty-Plus Service purchased in the United States is only valid within the United States.

As you may expect, service under a *Warranty-Plus* Agreement does not apply if the failure is caused by misuse or inadequate care or maintenance, such as:

(a) Abuse or cannibalization of products.
(b) Damage from repair attempts by non-Tektronix personnel.
(c) Improper use or connection to incompatible equipment.
(d) Modification or integration that increases time or difficulty in servicing your product.

Firm Price Calibration and Repair Services

Tektronix-backed service for your instrumentation products does not stop with the Warranty and *Warranty-Plus* programs. As the bar chart illustrates, Tektronix provides the fullest possible range of calibration and repair services. Three calibration levels provide a wide range of services including on-site cal verifications, overnight service, free pick up and delivery, free NBS traceability, test data, wet washes, and cosmetic services. Whatever your calibration needs, Tek service has a package to fit.

M-OPTIONS
***Warranty-Plus* Service With One-Year Product Warranty**

Product Warranty	Year 1	Year 2	Year 3	Year 4	Year 5	Description
M1=1 year coverage plus		Repair coverage CAL	Repair coverage CAL			Provides two calibrations (one each) and warranty-like repair coverage in years 2 & 3 of product ownership.
M2=1 year coverage plus		Repair coverage	Repair coverage	Repair coverage	Repair coverage	Provides warranty-like repair coverage in years 2, 3, 4, & 5 of product ownership
M3=1 year coverage plus		Repair coverage CAL	Repair coverage CAL	Repair coverage CAL	Repair coverage CAL	Provides four calibrations (one each) and warranty-like repair coverage in years 2, 3, 4, & 5 of product ownership
M4=1 year coverage plus	CAL	Repair coverage CAL CAL	Repair coverage CAL CAL			Provides five calibrations, one in year 1, and two each in years 2 & 3 of product ownership, and warranty-like repair coverage in years 2 & 3 of product ownership
M5=1 year coverage plus	CAL	Repair coverage CAL CAL	Repair coverage CAL CAL	Repair coverage CAL CAL	Repair coverage CAL CAL	Provides nine calibrations, one in year one, and two each in years 2, 3, 4, & 5 and warranty-like repair coverage in years 2, 3, 4, & 5 of product ownership.

Our repair offerings start at the basic repair level for one designated failure. For instruments with more extensive repairs, Tek offers additional service levels ranging from a single repair, to complete refurbishing.

Tek also offers combined services of calibration and repair. These make it efficient and economical for you to let us handle both tasks at one time.

Agreements
Calibration and Repair Services

For the most cost effective management of maintenance beyond the Warranty and *Warranty-Plus* periods, Tek Service offers Support Agreements. A Support Agreement provides long term, planned care for your equipment at a lower price.

With a Support Agreement, you know the costs up front, can pre-schedule calibrations, and cover most repair needs. Compared with per incident service, the overall savings of a Support Agreement are significant, and it provides even faster turnaround times.

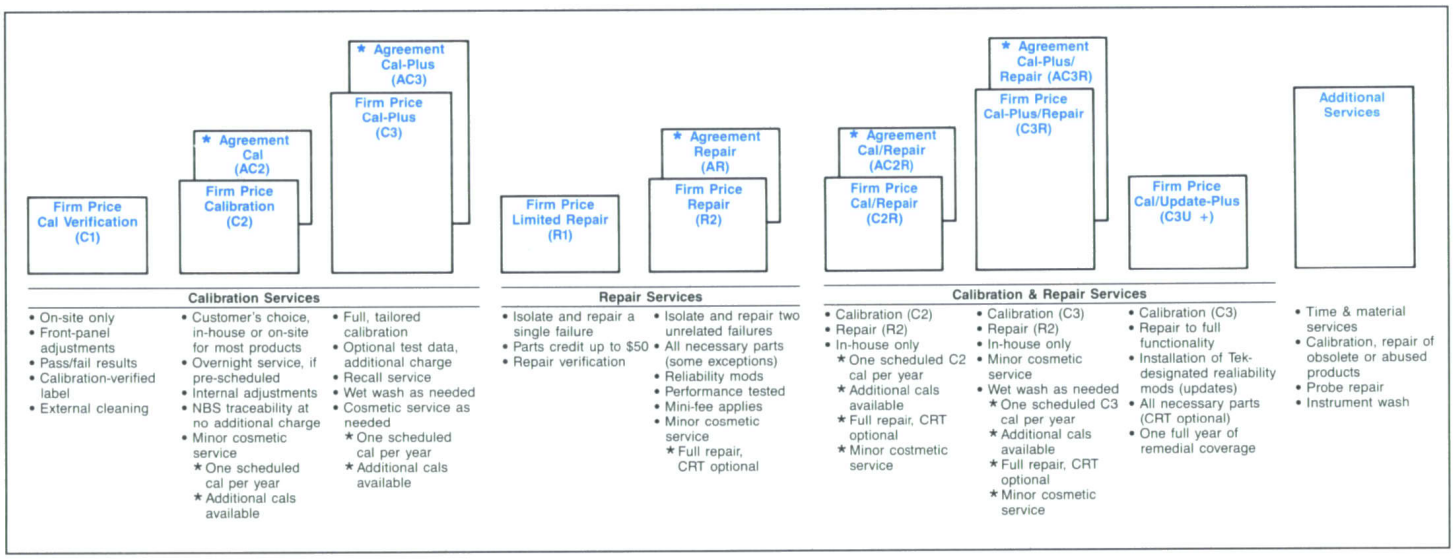
Special Services

You can also purchase extra services not provided by our other calibration or repair coverage. These activities include time and material service, calibrations and repair of obsolete products, probe repair, and instrument wash. We will inspect the product and quote a price for the work before performing any servicing.

For the phone number of the Tektronix Service Center nearest you, consult the listings in the back of this catalog.

M-OPTIONS
WARRANTY-PLUS SERVICE WITH THREE-YEAR PRODUCT WARRANTY

Product Warranty	Year 1	Year 2	Year 3	Year 4	Year 5	Description
M1=1, 2, & 3 year coverage plus		CAL	CAL			Provides two calibrations (one each) in years 2 & 3 of product ownership
M2=1, 2, & 3 year coverage plus				Repair coverage	Repair coverage	Provides warranty-like repair coverage in years 4 & 5 of product ownership
M3=1 year coverage plus		CAL	CAL	Repair coverage CAL	Repair coverage CAL	Provides four calibrations (one each) in years 2, 3, 4, & 5 and warranty-like repair coverage in years 4 & 5 of product ownership
M4=1, 2, & 3 year coverage plus	CAL	CAL CAL	CAL CAL			Provides five calibrations, one in year 1, and two each in years 2 & 3 of product ownership.
M5=1, 2, & 3 year coverage plus	CAL	CAL CAL	CAL CAL	Repair coverage CAL CAL	Repair coverage CAL CAL	Provides nine calibrations, one in year one, and two each in years 2, 3, 4, & 5 and warranty-like repair coverage in years 4 & 5 of product ownership



Customer Service Training Offerings

- Service Training Classes
- Technology Concept Classes
- Operational Instrumentation Training
- Self-Study Packages
  - Video Tapes
  - Audio Tapes
  - Packages
- Training Documentation
  - Training Guides
  - Service Manuals

Service Training Classes

Professional training provides your technicians the same opportunity to learn the latest maintenance techniques in identical courses used to train Tektronix technicians. We emphasize the "How to Fix" philosophy.

Our formal classroom training is intensive, with lectures and hands-on labs. Tektronix service instructors sharpen your skills in troubleshooting, isolating faults, and repairing Tektronix products. You learn factory-approved preventive maintenance procedures for long product life and maximum uptime.

On-site custom training is available. We have the flexibility within our programs to provide training at your location, enabling you to save costly travel expenses. By tailoring the class presentations and materials to your exact needs, you receive maximum value for your training investment.

Technology Concept Classes

We offer professional development in contemporary concepts technology. Our training focuses upon state-of-the-art developments in the areas of Logic Analysis, Microprocessor Development Labs, Digitizing Oscilloscopes, Computer Graphics and Spectrum Analysis.

These seminars are offered on a scheduled basis at various locations throughout the United States and may be conducted at your location if you desire. Use these seminars to enhance the professional development of your engineers and technicians in the instrumentation world.

Operational Instrumentation Training

To get the most from your Tektronix products, register in one of the various operational instrumentation training seminars offered by Tektronix Service Training. Our seminar/workshops combine classroom lecture with hands-on labs that emphasize "How to Use" philosophy.

These sessions can be conducted at your location to satisfy your requirements. Multiple product offerings are available, if you request. This high-quality training increases your productivity and provides you with "Ease of Use" necessary to grow in your personal development.

Self-Study Packages

Study on the job or at home. Our self-study video/audio tapes and training packages include exercises to help you quickly develop skills in logical diagnosis and repair.

Tektronix Service Training packages provide interactive, hands-on instruction for comprehension of troubleshooting and repair techniques at your own bench. Our tapes are quality products that introduce basic concepts to novice technicians and advanced multimedia packages for experienced service specialists. Build your own library of relevant training tapes and materials. Training packages are the next best thing to being in class.

Training Documentation

Tektronix Service Training develops the complete program for your training needs. In addition to formal training, we can provide a complete instructor package consisting of: class outline; lesson plan; instructor guide; student workbook; lab exercises; and visual projections. Service manuals, created by the Service Training group, can be developed to satisfy your specific needs. Our professional technical writers develop materials which emphasize the "How to Fix" techniques used by the Tektronix service specialist.

Our training programs have been used by various branches of the Armed Services with high acclaim. Join the team of professional training offered by Tektronix Service Training.

Call Tektronix Today

Formal classroom training is available at the Tektronix Training Facilities in Beaverton, Oregon, as well as Atlanta, GA; Boston, MA; Chicago, IL; Dallas, TX; Denver, CO; Irvine, CA; and Santa Clara, CA.

To register for the formal training classes or information on other training services, call:

1 (800) 835-9433 ext. WR1407

or write:
Tektronix, Inc.
Walker Road Industrial Park
P.O. Box 4600 M/S 94-925
Beaverton, Oregon 97076

Check the Specifications. You'll Find Long Product Life Designed-In.

Reliability Standards Second to None

Tek products are engineered for high reliability. Components and assembled products of every prototype and preproduction model are subjected to "accelerated-life" reliability tests in our Labs. If any fall short of Tek Standards, changes are made. Manufactured products are thoroughly tested before they're fitted in custom-designed, lab-tested shipping cartons.

Product Specifications to Meet Your Environment

In Tek's Environmental Labs, field conditions are taken to extremes. Shock, vibration, high humidity, electromagnetic radiation, electrostatic discharge, power line serge, high/low temperature and altitude tests are conducted.

The specification limits for humidity, vibration, shock and transportation are intended to be beyond what is expected in use. Operation at these extremes may cause minor physical deterioration but should not cause electrical performance to deteriorate outside specifications. Continual use at the specified limits of temperature and altitude should not cause significant short-term deterioration. Higher temperature will reduce long-term reliability. The EMC test is completely nondestructive.

GENERAL TERMS OF SALE

Credit and Payment Terms

Tektronix, Inc. offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning. Credit accommodations must be arranged with Tek's Credit Department. Orders and request for credit accommodations should be placed with your local Tek Sales Office, listed on the inside back cover.

If, in the judgement of Tektronix, the financial condition or payment record of the Buyer at any time does not justify shipment of order on the payment terms requested, Tektronix may refuse to ship unless it receives payment in advance, or at its option, payment upon delivery of equipment. Businesses established for six months or less may not meet minimum requirements for extended and/or installment terms of sale.

The following terms may be arranged with a Tektronix Sales Office.

Net 30 Days Standard Terms

Standard terms of sale are Net 30 days following the date of invoice. There are no discounts for early payment.

60, 90, and 120 Days Extended Terms of Sale

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended. Request for extended terms must be made at the time of order placement.

Installment Purchases—Security and Lease Agreements

This program provides monthly installment payment terms while Tektronix products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

Security and Lease terms are not invoiced. Reminders of each installment are sent to the customer 10 days prior to the due date. The due date of each monthly payment on an installment term will be approximately 30 days from the date of shipment and every 30 days thereafter until completion of the contracted term. Failure to receive any reminder notice from Tektronix shall not affect customer's obligation to pay charges when due.

Except for standard warranty, maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance coverage may be purchased where offered as an option to the instrument or may be purchased as a separate transaction. Maintenance ordered as an option may be financed along with the product.

The customer is required to pay applicable property taxes, licenses, etc. and furnish adequate insurance to Tektronix for loss and damages for both Leases and Security Agreements.

Security Agreement

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from $1000 for six months to $2000 for thirty-six months. Longer terms of 48 months to 60 months are available by quotation for financed balances of more than $25,000. There are no maximum finance balances. Upon completion of the term of the Security Agreement and prescribed payments, the customer owns the equipment.

Lease Agreement (Minimum is $1,000)

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement, the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental...it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease, there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price. Not available for Information Display Products.

Information Display Products

Information Display Computer Graphics Products are available under 3 expanded Leasing programs. Terms vary from 90 days to 4 years.

Comprehensive Lease—This full service lease provides 7 features ensuring customer flexibility. Key features include maintenance, product upgrade, and purchase credits. *Basic Lease*—Customers can use this program to acquire products at our lowest monthly rates. *Ownership Lease*—This even payment plan ensures title transfer at the lease end. No down payment or ending balloon payment is required.

In addition to these standard programs, specialized leasing programs answer customer needs in the areas of new product evaluation, short-term rental, supplying interim products for delayed items, credit acceptance, and others. Custom Leases can also be structured, providing a tailored solution for individual customer requirements.

Minimum Order

The minimum acceptable order is $25.00.

Shipment

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified. Shipment will be made via the most economical method, and air shipments will be insured at full value unless your order instructs otherwise.

HARDWARE WARRANTY SUMMARY

Tektronix warrants to its Customers that the products that it manufactures and sells will be free from defects in materials and workmanship for the periods set forth in the table below. If any such product proves defective during the applicable warranty period, Tektronix, at its option, either will repair the defective products without charge for parts and labor or will provide a replacement in exchange for the defective products.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site for certain categories of products, as indicated in the table below, if Customer's site is within the normal on-site service area. Tektronix will provide on-site service outside the normal on-site service area only upon prior agreement and subject to payment of all travel expenses by Customer. In all other cases, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the service center is located. Customer shall be responsible for paying all shipping charges, duties and taxes, if the product is returned to any other location. The locations at which the services will be provided for different categories of products or product groups are set forth below.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

PRODUCT CATEGORIES	WARRANTY PERIOD	SERVICE LOCATION
Oscilloscopes (except 2200, 2300, 2400 Series) TM 500/TM 5000 Series; Communications Network Analyzers (except 834 Series, 835 & 836); Logic Analyzers (except 9200 Series); Spectrum Analyzers (except 494 and 494P); Television Products (except 1980 and 650 Series); Waveform Digitizers; Curve Tracers; Photometers/Radiometers; Cameras; Carts; Probes; CRTs; Isolators; Computer Graphics Products: 4100H Series, 4900H01; Test System Interface Family	1 year from date of shipment	Service Center designated by Tektronix
Oscilloscopes: 2200, 2300, 2400 Series; Spectrum Analyzers: 494 and 494P; Monitors: 650 Series; Communications Network Analyzers: 834 Series, 835, 836 and 067-0986-00	3 years from date of shipment	Service Center designated by Tektronix
Monitors: 606B, 608, 620, 634	3 months, except 1 year from date of shipment for CRT	Service Center designated by Tektronix
Computer Graphics Products (except 4100H Series, 4900H01 and those listed below); Intelligent Graphics Workstations; Monitors: GMA 201, GMA 303; 1980; 4041 Controller; Computer Aided Software Engineering products (except V-Systems, MV Systems); Artificial Intelligence Systems	3 months, except 1 year from date of shipment for CRT	Customer's site if within normal on-site service area
Computer Graphics products: 4109A, 4205, 4207, 4208, 4209	1 year from date of shipment	Customer's site if within normal on-site service area
Custom Test Systems; Semiconductor Test Systems, Computer Aided Software Engineering Products: V-Systems, MV Systems; Logic Analyzers: 9200 Series	3 months, except 1 year for CRT, beginning on the date of installation by Tektronix, or one month from date of shipment, whichever is earlier	Customer's site if within normal on-site service area
Parts, Assemblies, Supplies and Test Fixtures: All 9-digit part numbered items except Probes, CRTs, and 067-0986-00	3 months from date of shipment	Service Center designated by Tektronix
Service	3 months from date of shipment or date of completion if performed on-site	Location where original service was performed

SOFTWARE WARRANTY SUMMARY

Tektronix warrants that any software product for which Tektronix publishes a corresponding "Software Product Description" will conform to the specifications set forth in the Software Product Description, when used properly in the specified operating environment, for a period of three (3) months. The warranty period begins on the date of shipment, except that if the program is installed by Tektronix, the warranty period begins on the date of installation or one month after the date of shipment, whichever is earlier. If any such software product does not conform as warranted, Tektronix will provide the remedial services specified in the applicable Software Product Descriptions. Tektronix does not warrant that the functions contained in the software product will meet Customer's requirements or that the operation of the programs will be uninterrupted or error-free or that all errors will be corrected. Software products for which Tektronix does not publish a Software Product Description, or for which Tektronix does not set forth specifications in the Software Product Description, are provided "as is" without warranty of any kind, either express or implied; except that, Tektronix warrants that the media on which such software products are provided will be free from defects in materials and workmanship for a period of three (3) months from the date of shipment. If any such medium proves defective during this warranty period, Tektronix will provide a replacement in exchange for the defective medium.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangments for such service in accordance with the instructions received from Tektronix. If Tektronix is unable, within a reasonable time after receipt of such notice, to provide the remedial services specified in the applicable Software Product Description, when such services are indicated, or provide a replacement that is free from defects in materials and workmanship, Customer may terminate the license for the software product and return the software product and any associated materials to Tektronix for credit or refund.

This warranty shall not apply to any software product that has been modified or altered by Customer. Tektronix shall not be obligated to furnish service under this warranty with respect to any software product a) that is used in an operating environment other than that specified or in a manner inconsistent with the User's Manual and documentation or b) when the software product has been integrated with other software if the result of such integration increases the time or difficulty of analyzing or servicing the software product or the problems ascribed to the software product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO PROVIDE REMEDIAL SERVICE WHEN SPECIFIED, REPLACE DEFECTIVE MEDIA, OR REFUND CUSTOMER'S PAYMENT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

OEM COMPONENTS

Special Information for OEM

At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation—we offer these and other products on a special basis to the original equipment manufacturer.

Choose the Performance Level to Match Your System

In many product areas, our wide range of OEM components allows you to select just the optimal performance you need for the system you are building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you select exactly the performance level you need—no more, no less.

Special OEM Terms and Pricing Help Keep You Competitive

Ask your local Tektronix representative about the special OEM terms and pricing available to you.

Service and Support—When and Where You Need It

Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

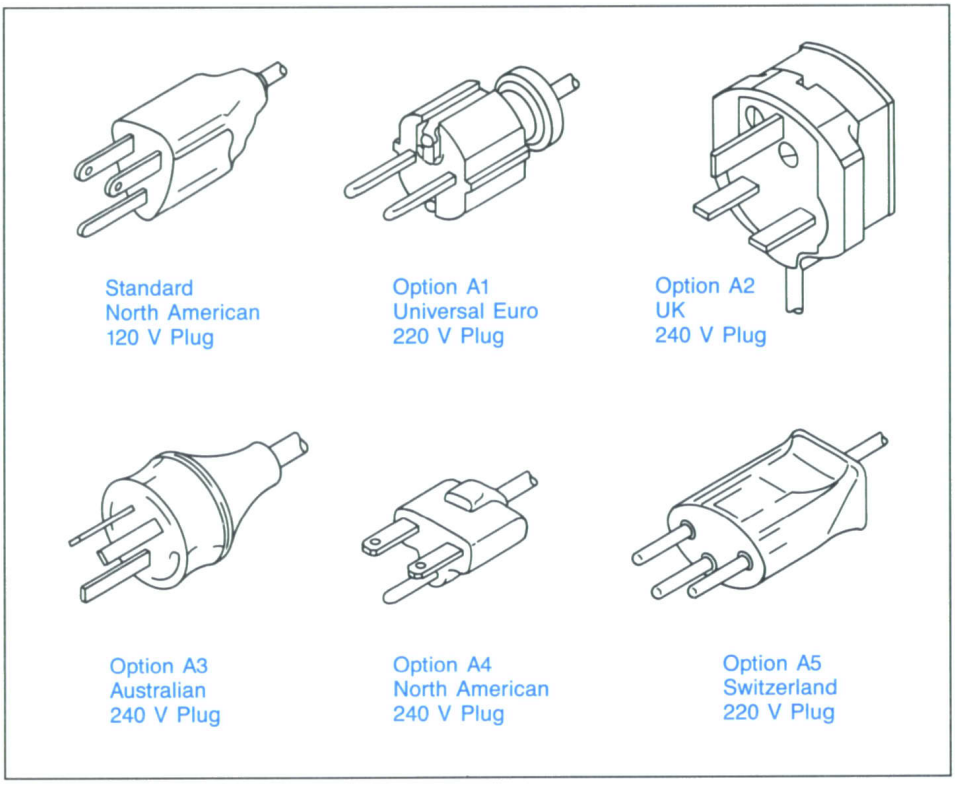
If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

You and Tektronix: A Quality Partnership

Explore the advantages of working with Tektronix: excellence in products, support, and service.

Your local Tektronix representative can help you obtain full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.



POWER SOURCE CONSIDERATIONS

Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below and wired for the voltage as indicated, if specified on the purchase order.

North American	120 V	Standard
Universal Euro	220 V	Option A1
United Kingdom	240 V	Option A2
Australian	240 V	Option A3
North American	240 V	Option A4
Switzerland	220 V	Option A5

The power cord/plug options may become available on instruments not specified in this catalog. Refer to the individual product ordering information for those products offering these options as of publication date.

Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

Power-cord coding follows one of the two following schemes:

	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow

For customers in areas not listed, see below for your nearest office.

Customers in Eastern Europe, Near- and Middle East contact:
Tektronix Ges.m.b.H., Austria

Customers in Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Djibouti, Equatorial Guinea, Gabon, Guinea, Malagasy, Mali, Monaco, Morocco, Niger, Togo, Zaire contact: Tektronix S.A., France

Customers in Andorra, Angola, Azores, Gibraltar, Spanish West Africa contact: Tektronix Espanola, S.A., Spain

Customers in unlisted African, South American, or Asian locations contact:
Tektronix Inc., U.S.A.
U.S. Export Sales
P.O. Box 500 D/S 73-323
Beaverton, OR 97077 USA
Phone: (503) 627-1619
Telex: 4742110 Tek Exp
Fax: (503) 627-6905

ALGERIA
Product Information
Tektronix, Bureau de Liaison-Algerie
Bureau N5, Niveau C
Hotel El-Aurassi
BD Frantz-Fanon
Alger
Phone: 213 ( ) 648252, Ext-665
Telex: 67043 TEK DZ

Service
Entreprise Nationale Des Industries Electroniques
Unite de Maintenance et Calibration des Equipements Electroniques
MCE 1, BP 121
Route de Mascara Zone - Industrielle
Sidi Bel-Abbes
Phone: 213 ( ) 242269
Telex: 16021 MCE1 DZ MCE2
Lotissement El-Idrissi
Alger
Phone: 213 782074/782076
Telex: 66108 DELNA D2

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Telex: (390) 22284 COASN AR
Fax: 54 (1) 331-9763

Cordoba
25 de Mayo No. 1930
Cordoba
Phone: 54 (51) 3037

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Tektronix Australia Pty. Limited
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Adelaide, South Australia 5000
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Belconnen
Canberra, Austr. Capital Terr. 2617
Phone: 61 (62) 516111
Fax: 61 (62) 51-4509

Melbourne
259-263 Whitehorse Rd.
Balwyn, Victoria 3103
Phone: 61 (3) 836-3355
Telex: (790) 35880 TEKMEL AA
Fax: 61 (3) 836-6592

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66 Wellington Street
East Perth, West Australia 6000
Perth
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Queensland
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A-1100 Vienna
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Fax: 43 (222) 68-66-00

Graz
Foellingerstrasse 9E
A-8044 Graz-Maria Trost
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Fax: 973 725404

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Telex: (950) 642418 DCCI BJ

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